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# THE COLD STORAGE OF EGGS AND POULTRY

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## INTRODUCTION

The development of the cold-storage warehouse is the outgrowth of an economic demand brought about by the shift of the farm population to the urban centers of the country, and the economic and other benefits that result from the conservation of food supplies at seasons of surplus production for use during shortages of current production.

During our colonial period a farmer's family was practically self-sufficient. At that time more than 96 percent of the total population of the Nation lived on farms. Gradually the proportion of city dwellers increased, until on January 1, 1935, the Bureau of the Census estimated the farm population at only 25 percent of the total.

Although the proportion of people on farms is only about one-fourth as great as 60 years ago, the food supplies have increased so that they are frequently larger than can be sold at the time they are produced. Scientific farming methods, improved farm machinery, eradication and control of diseases and insects, better transportation, refrigerator cars, and cold storages have increased the productivity per farm, and have preserved highly perishable food supplies and made them available for consumption for long periods after they were harvested (fig. 1).

To offset the constant shift in our population from farms to cities, food conservation became an economic necessity, and no means of preserving perishable products in their original condition has been developed that is so satisfactory as keeping them in cold-air temperatures. The use of chemicals as a preservative is prohibited in the case

of most commodities, and methods of smoking, salt-curing, or pickling have not been found to be practicable with poultry products as they have with various other meat products. Just as modern reservoirs insure an adequate and constant supply of water for the inhabitants of cities, so does the modern cold storage under present conditions assure an adequate and constant supply of perishable food supplies to consumers in every section of the country.

The increase in the production of eggs and poultry is due primarily to the development of the cold-storage warehouse. Formerly, during the heavy producing season the supply of both eggs and poultry was large, but only a limited quantity could be marketed. Until the storages were developed there was no adequate incentive for farmers to produce these supplies, for they were not salable in quantity. The poultry industry would not have become one of the most important agricultural activities in the country were it not possible to conserve the supply from the surplus-producing season to the season of underproduction.

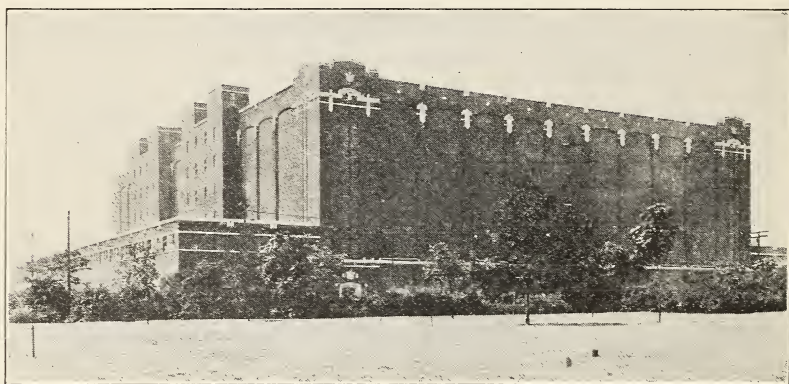


FIGURE 1.—A modern cold-storage warehouse with a capacity of more than 50,000,000 pounds of perishable products. A month's supply of perishable foods sufficient to supply the entire population of a city the size of Chicago can be stored within its walls at one time.

#### EXTENT AND VALUE OF POULTRY AND EGG STORAGE

If the production of eggs were evenly distributed throughout the year, or if equal quantities of fresh-killed poultry were available for market each month, the marketing of these two products would be much simplified. But more than one-half of the total egg crop for the year is produced during the 4 months of March, April, May, and June, and the total receipts of dressed poultry in the four principal markets of the country for the 3 months of November, December, and January are almost equal to the total receipts in those markets for the remaining 9 months.

The farm value of the egg crop for 1935 was approximately \$582,000,000. In that year the stock of eggs in cold storage on August 1 (the peak holding of the year) was 7,947,000 cases in the shell and 116,264,000 pounds, equivalent to approximately 3,322,000 cases, of frozen liquid eggs. The total of 11,269,000 cases was about 13 per cent of the total estimated production of eggs in the United States for that year.

## SEASONAL RECEIPTS OF EGGS AT NEW YORK BY REGIONS OF ORIGIN, 1921-36

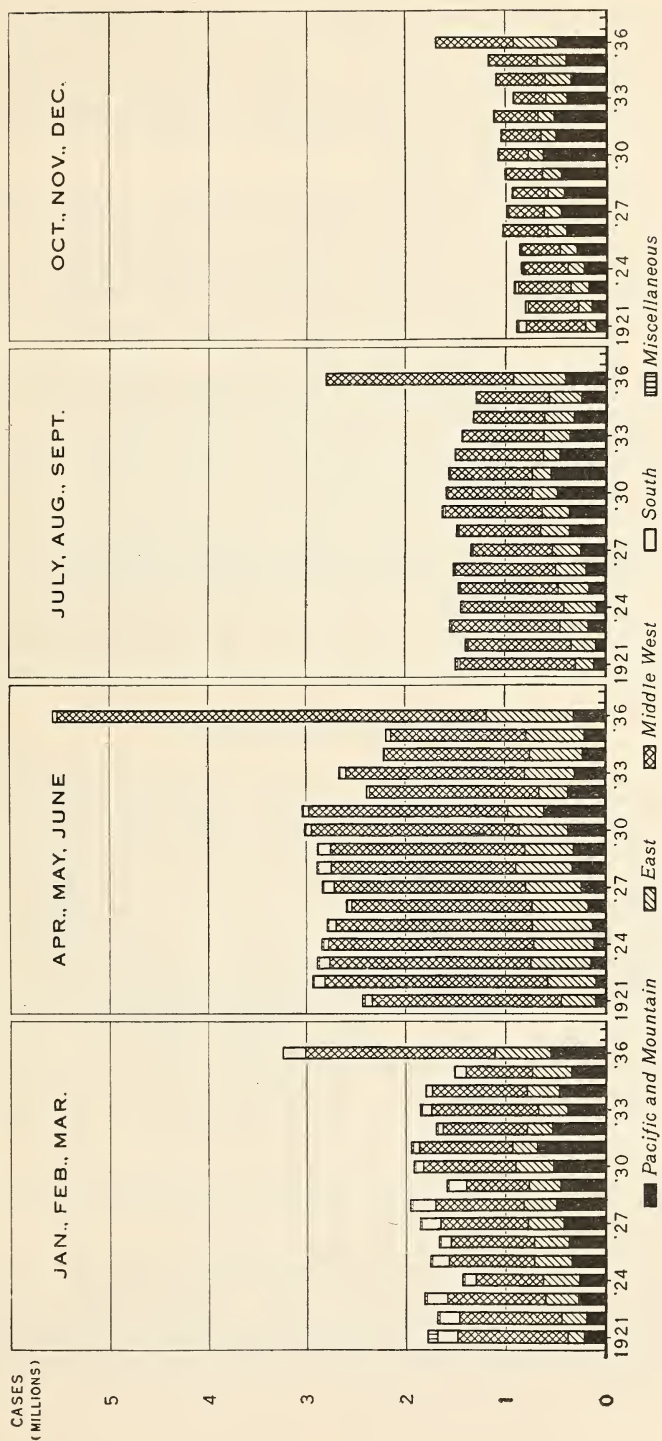


FIGURE 2.—SEASONAL RECEIPTS OF EGGS AT NEW YORK, BY REGIONS OF ORIGIN, 1921-36.

The heavy receipts of eggs during the spring months are preserved in cold storage until the fall and winter months, when a scarcity of fresh eggs develops. Because of the improvement of the refrigerator car, eggs can now be satisfactorily shipped from one end of the country to the other.

The estimated value of poultry raised in 1935 was over \$349,000,000, at farm prices. This does not include the value of turkeys, ducks, and geese, or other miscellaneous poultry. On January 1, 1936, the stock of poultry in cold storage was more than 107,000,000 pounds, which at farm prices represents a value equivalent to about 4.5 percent of the value of all chickens raised in 1935 and probably about 4 percent of the value of all poultry raised.

The peak of storage stocks for eggs in the shell is usually reported first of August; then withdrawals gradually increase until by the first of January the supply is almost exhausted. Sometimes a few are carried until February and even as late as March, sometimes the new crop is beginning to be placed in storage before the old crop is entirely withdrawn. Shell eggs are never carried through the second season.

The supply of frozen eggs held in storage varies to a much less extent from month to month, because they can be carried over from one season to another with less depreciation in their quality than can shell eggs. The holdings are usually reported at their peak on August 1, and usually on March 1 the storage supply is at its lowest, although sometimes the low point is reported on April 1 (fig. 2).

More poultry is stored during November than during any other month; the peak of storage holdings is usually reported on January 1, and the low point is reported in some month from June to September. Quantities of poultry are often carried over from one year to another, but because of considerable deterioration in the product in the second year, holders always try to dispose of their stock from season to season.

#### GROWTH OF THE INDUSTRY

Cold storage, as we now know it, had its beginning about 1890. Previous to that time such cold storages as existed were cooled with a mixture of crushed ice and salt. Cold-storage houses were much less numerous than now, but some of them had considerable capacity. The largest in the world, located in the Middle West, contained 1,800,000 cubic feet of storage space. Many of the mechanically cooled storages of the present time have a capacity of many times that amount, devoted to the storage of poultry and dairy products alone.

The storage industry grew rapidly with the development of mechanical refrigeration. During the first 15 years of this growth the capacity of storage space reached a total of over 100,000,000 cubic feet. During the next 10 years, or by about 1915, this capacity had doubled, and it again doubled in the next 10 years to a capacity of 400,000,000 cubic feet, exclusive of privately owned storages and meat-packing plants.

The total storage capacity of the country in 1936, including that in meat-packing plants and private storages, amounted to more than 710,000,000 cubic feet.

With the exception of that used for apples, more space is used for the storage of eggs in the public warehouses than for any other one commodity. Frozen poultry ranks fourth. Without eggs and poultry, cold storage could not have attained the present place among the leading industries of the country that it holds today (figs. 3 and 4).

The first record by the United States Department of Agriculture of the stocks of shell eggs in cold storage was made in 1915, when the peak of the holdings, reached in September of that year, amounted to 5,683,000 cases. Until recent years holdings have steadily increased, and the largest holdings on record were 11,198,000 cases in storage on August 1, 1930, which was almost double the quantity stored in 1915.

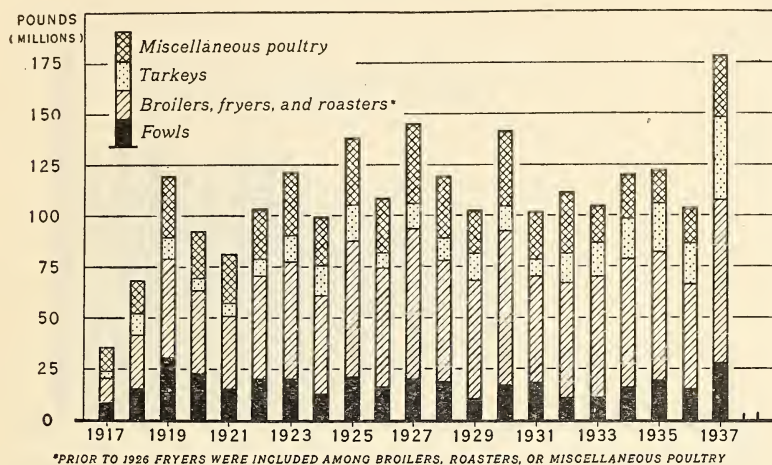


FIGURE 3.—COLD-STORAGE HOLDINGS OF FROZEN POULTRY, FEBRUARY 1, 1917-37.

The long season of production makes available for storage a greater number of roasting chickens than of any other class of poultry.

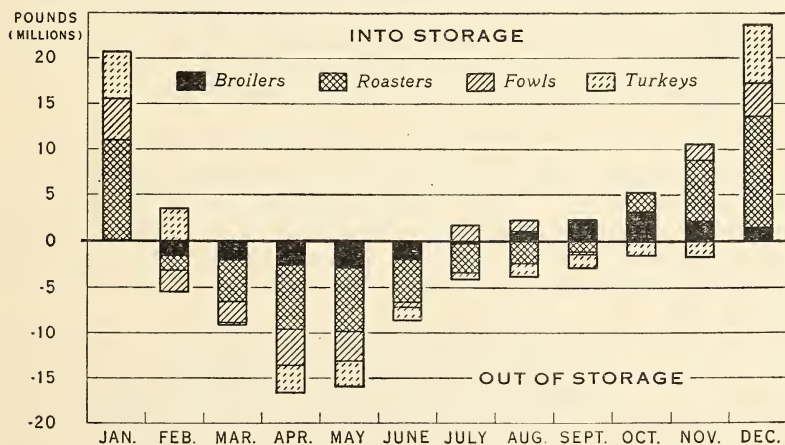


FIGURE 4.—COLD-STORAGE MOVEMENT OF BROILERS, ROASTERS, FOWLS, AND TURKEYS, 5-YEAR AVERAGE, 1931-35.

The into-storage movement during the 3 months November, December, and January is almost as great as that during the remaining 9 months.

Holdings of frozen eggs show a still more rapid growth. The first Government report in 1916 showed 6,457,000 pounds as the peak holding, and there have been increases in practically every year since then. In 1926 the September 1 report showed 52,630,000 pounds in

storage, which was the high record up to that time; but by August 1, 1937, the high record for all time was reached, when the total holdings amounted to 167,000,000 pounds (fig. 5). In terms of shell eggs, the supply of frozen eggs in storage on August 1, 1937, would amount to approximately 4,767,000 cases. This is more than one-half of the quantity of shell eggs stored.

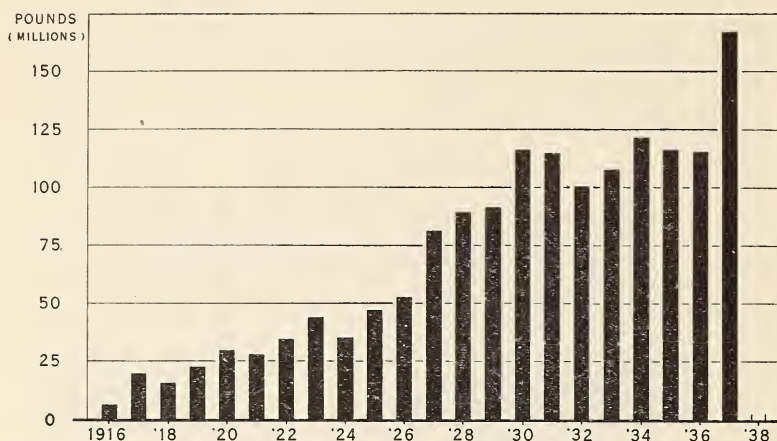


FIGURE 5.—PEAK OF COLD-STORAGE HOLDINGS OF FROZEN EGGS, 1916-37.

The trend of storage holdings has been gradually upward, frozen-egg holdings increasing more rapidly than the shell-egg holdings.

Government records of the holdings of poultry in storage began in May 1916, and the peak holdings of 31,175,000 pounds were reached in November of that year. The largest holdings in the history of the industry were reached in January 1937, when the total of all classes of poultry in storage amounted to 187,887,000 pounds (fig. 6).

#### LOCATION AND DISTRIBUTION OF STORAGE WAREHOUSES

The geographical location of the warehouse is of great importance to its financial success. Most of the larger plants are located in, or are easily accessible to, the larger terminal markets. Others, usually the smaller plants, are erected near the producing centers, and some are located at intermediate points. Each group has its advantages.

TABLE 1.—Distribution of egg and poultry holdings in the United States and geographic divisions, by selected dates

| Geographic division     | Cold-storage holdings of—      |                                    | Geographic division     | Cold-storage holdings of—      |                                    |
|-------------------------|--------------------------------|------------------------------------|-------------------------|--------------------------------|------------------------------------|
|                         | Shell eggs,<br>Aug. 1,<br>1936 | Frozen<br>poultry,<br>Feb. 1, 1937 |                         | Shell eggs,<br>Aug. 1,<br>1936 | Frozen<br>poultry,<br>Feb. 1, 1937 |
| New England.....        | 1,000 cases<br>256             | 1,000 pounds<br>11,902             | West South Central..... | 1,000 cases<br>155             | 1,000 pounds<br>3,196              |
| Middle Atlantic.....    | 2,031                          | 63,188                             | Mountain.....           | 100                            | 789                                |
| East North Central..... | 2,438                          | 48,464                             | Pacific.....            | 634                            | 13,031                             |
| West North Central..... | 1,270                          | 33,003                             |                         |                                |                                    |
| South Atlantic.....     | 191                            | 2,204                              | United States.....      | 7,337                          | 178,072                            |
| East South Central..... | 262                            | 2,295                              |                         |                                |                                    |

Table 1 shows the geographical distribution of egg and poultry holdings in warehouses of the United States, by sections, and the peak holdings of eggs and poultry in these warehouses.

#### WAREHOUSES IN PRODUCING SECTIONS

Warehouses located in the producing sections have the advantage of receiving their goods in a fresher condition than can the city warehouses. The sooner both eggs and poultry are placed in storage after they are prepared, the better will be the delivered product, and considerable freight and storage charges will be saved by culling out and disposing locally of both eggs and poultry that are not suitable for storage. There is less danger that cracked and broken eggs will go into the cooler rooms if the eggs are stored at the point where they have been graded, as the expense in recandling at the terminal warehouse, as well as the insufficient space available, would usually make repacking impracticable. Labor and power facilities are often cheaper at the country points, and the construction of the warehouse and the ground on which it is built usually cost less.

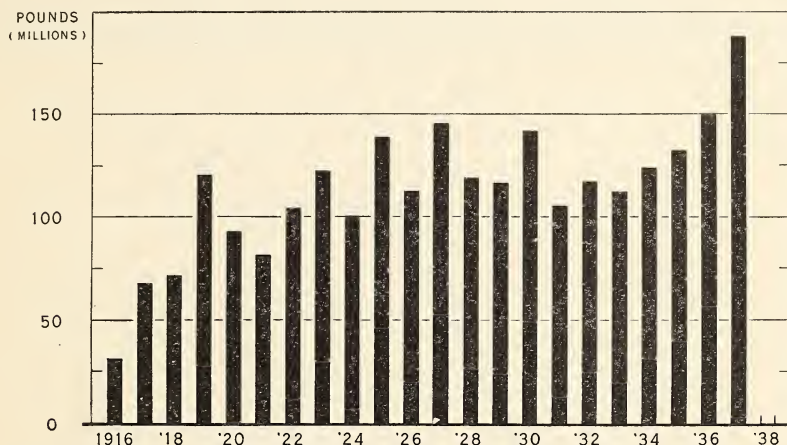


FIGURE 6.—PEAK OF COLD-STORAGE HOLDINGS OF FROZEN POULTRY, 1916-37.

Storage stocks vary considerably from year to year.

The great difficulty in successful operation at country points is in keeping the storage rooms well filled throughout the year. The peak of egg holdings lasts only 5 or 6 months, after which withdrawals and consequent emptying of the storage rooms rapidly occur. After 9 months of storage no appreciable revenue is derived from this source, and the storage rooms remain practically empty for the remainder of the year. A more uniform revenue is derived from poultry storage, although the peak holdings in recent years have been almost four times as great as the lowest holdings for the same year (fig. 7). This means that during the interval between the high and low holdings a great amount of storage space would not be occupied. The country storage plants have less opportunity to fill their rooms with products other than poultry and eggs than do the city operators, whose revenue comes from commodities that are produced in all sections of the country.

## WAREHOUSES IN STORAGE-IN-TRANSIT SECTIONS

The storage warehouses located at intermediate points between the producing sections and the terminal markets have some of the advantages as well as some of the disadvantages of the other two groups. They can fill their rooms with produce from a great part of the country, but they have to reload their products in cars and ship them to the consuming centers. The storage-in-transit privileges afforded by the railroads make such procedure possible, with practically the same freight rate as would apply to a through haul, but there is the added expense of rehandling, the danger of breakage, and delays in getting the commodities to the terminal markets. But a holder who has foods stored in warehouses so situated has the advantage of being able to ship his holdings to the market at which he can dispose of his stock to the best advantage.

## WAREHOUSES IN TERMINAL MARKETS

More than one-half of the total holdings of both eggs and poultry have been stored in the Middle Atlantic and East North Central States in recent years. As the largest centers of population are in these regions, the location of the storage houses for eggs and poultry in or adjacent to the largest cities is most favored by warehouse operators.

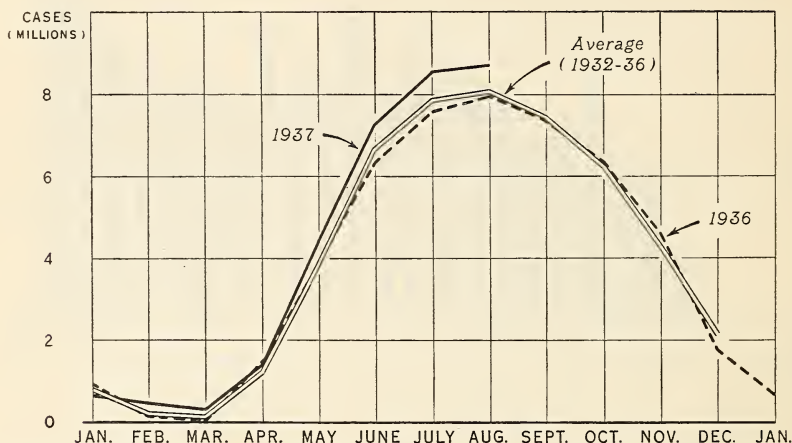


FIGURE 7.—COLD-STORAGE HOLDINGS OF CASE EGGS, BY MONTHS, 1936, AND JANUARY TO AUGUST 1937, AND 5-YEAR AVERAGE, 1932-36.

The heavy movement into storage begins in April and continues until June, the peak holdings usually being reached by the 1st of August. Withdrawals are heaviest in October, November, and December.

The large plants located in the terminal markets make food supplies available on short notice to large centers of population. Severe storms or railway congestion would not affect their ability to deliver goods at a few hours' notice. The holder of the stored products by having his supplies immediately available is able to take advantage of sudden market scarcity, and often obtains a higher price for his product than would be possible with later delivery. Added to this is the better opportunity of filling the egg and poultry rooms with other products during the season of low holdings (fig. 8).

## METHODS OF REFRIGERATION

Two methods of refrigeration have been used in maintaining proper temperatures in packing and storage rooms. In the first method ice is employed, or a mixture of salt and ice, as the refrigerating medium. Owing to the difficulty in maintaining uniform temperatures and humidity and the expense involved, this method has proved more or less unsatisfactory and is used only at some country collecting stations where the eggs and poultry are gathered and held for only a short time, or until a carload is accumulated.

The second and more satisfactory method is known as mechanical refrigeration. There are two types of mechanical refrigerating plants—the compression and the absorption.

In the compression plants the variations in pressures are effected by means of the compressor in conjunction with the expansion or throttling valve. In the absorption plant the variation in pressure is brought about through the direct application of heat, usually by means of steam. In either type of plant the evaporating or cooling coils may be placed directly in the room to be cooled, or they may be placed in a suitable brine tank and serve to cool the brine, the brine in turn being circulated through the room. The brine simply acts

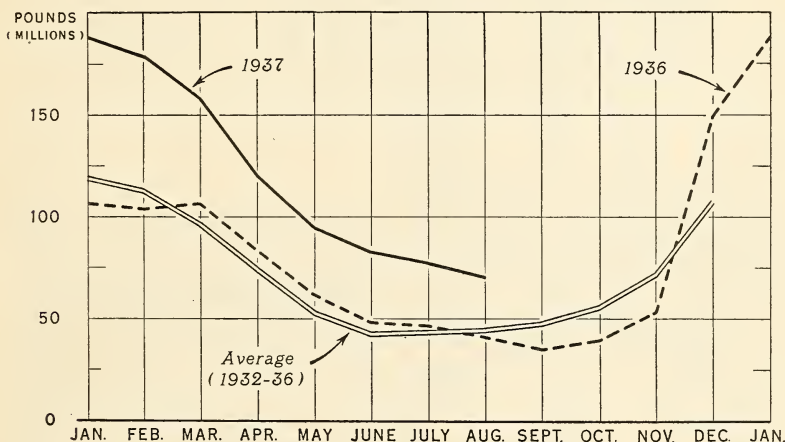


FIGURE 8.—COLD-STORAGE HOLDINGS OF POULTRY, BY MONTHS, 1936 AND JANUARY TO AUGUST 1937, AND 5-YEAR AVERAGE, 1932-36.

More poultry is stored during November than during any other month; the peak of storage holdings is usually reported on January 1 and the low point in some month from June to September.

as a heat transfer medium, absorbing heat from the products to be cooled and transferring it to the cooling coils where it gives up its heat. The former is known as the direct-expansion system, and the latter is known as the brine-circulating system. The brine-circulating system is in more general use than the direct-expansion system, especially in the larger plants, as it lends itself readily to more accurate temperature control and by its use there is eliminated the danger of the refrigerant escaping into the cold-storage room.

## CONSTRUCTION OF AN ICE-COOLED STORAGE ROOM

The development of modern machinery for artificial refrigeration, with its many advantages, has caused the old type of ice-chilled cooler to become rapidly obsolete.

The difficulty in maintaining uniform temperature and humidity control, as well as the operating costs, have proved to be factors decidedly in favor of the mechanical type. In some parts of the country, however, where a natural supply of ice is free for the cutting, some poultry and egg packers still use natural ice for their refrigeration. Its use is mostly limited to the preservation of products being prepared for shipment rather than for storage of long duration. Where mechanical refrigeration cannot be obtained the ice cooling, of course, is better than no cooling.

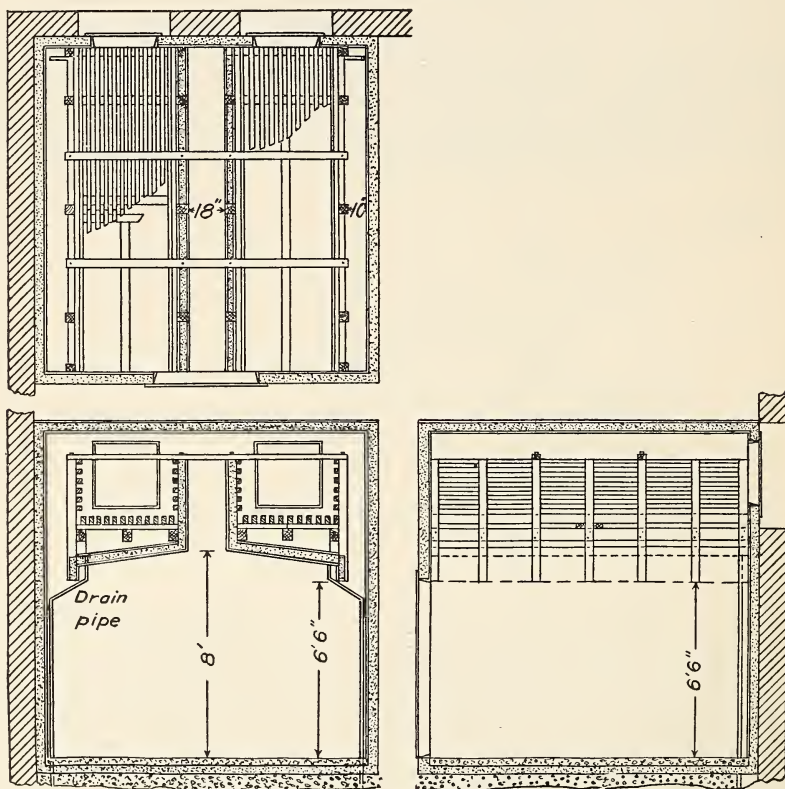


FIGURE 9.—Typical ice-cooled chill room with overhead bunker. End view.

Various types of construction have been used satisfactorily. Figures 9 and 10 show plans worked out by the former Bureau of Chemistry of the United States Department of Agriculture.

This type of cooler was designed primarily for packers whose output was too small to justify installation of mechanical refrigeration and is so arranged that coil pipes and machinery can be installed at a later time. Poultry to make a carload can be packed and ac-

cumulated in this cooler until ready for shipment at a much lower cost than it could be held in cracked ice.

By adding 10 to 15 percent of salt to the ice, temperature in this cooler can be maintained at several degrees below freezing point, if desired. By actual experiment, temperature of poultry was reduced from 101° to 30° F. in 24 hours.

Insulation of the room is accomplished by means of a double layer of 2-inch corkboard, plastered both inside and out with a half-inch coating of cement mortar. Corkboard of the same thickness is also embedded between cement layers of the floor and ceiling.

The bunker for holding the ice consists of a wooden framework lined with No. 6 gage galvanized wire mesh of 1-inch square openings, which allows free circulation of the cooled air to all parts of the box. The bunker space should occupy 25 percent of the space to be cooled,

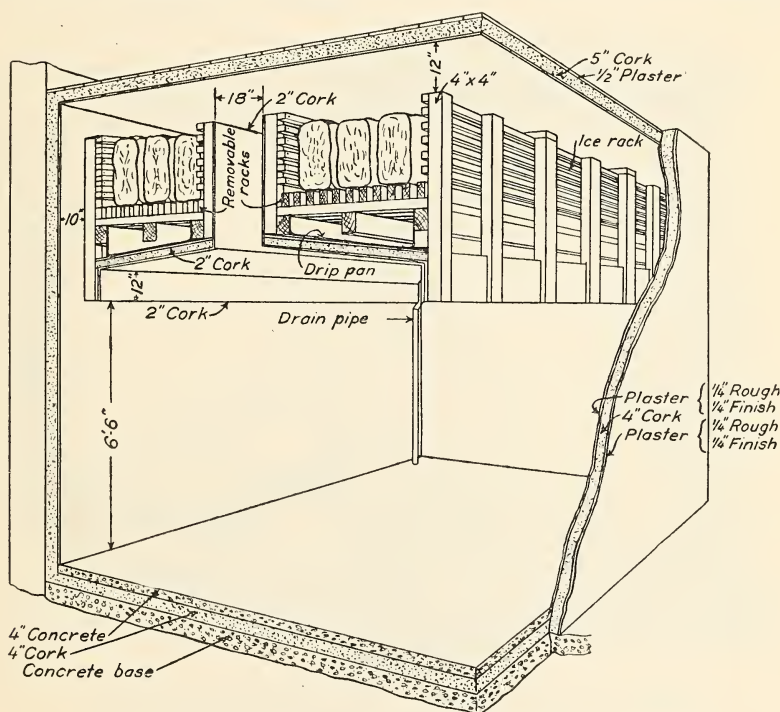


FIGURE 10.—Typical ice-cooled chill room with overhead bunker. Side view.

regardless of the size of the storage room. The cost of constructing a cooler of this type depends on so many factors that a definite figure cannot be given under ordinary conditions, but in most parts of the country the box could be built at a cost of approximately \$1,000 to \$1,200.

When building a room of this kind it is well to arrange the space to permit the installation of refrigerating coils to take the place of ice in case mechanical refrigeration is installed at a later date.

## CONSTRUCTION OF A MECHANICALLY COOLED STORAGE

To give in detail the construction of a modern cold-storage plant would be impossible in a publication of this size; only a few of the more important points can be here given. More detailed information can be procured by consulting local architects, or manufacturers of warehouse machinery and equipment, or reputable firms actively engaged in warehouse construction.

The location of the building is of primary importance. Excessive switching and drayage charges can be avoided if the warehouse is located adjacent to trunk-line railroads and on easily accessible streets.

Proximity to the wholesale egg and poultry markets is an important factor. The added cost of ground in such localities is usually offset by the service rendered to the patrons and consequent increased business.

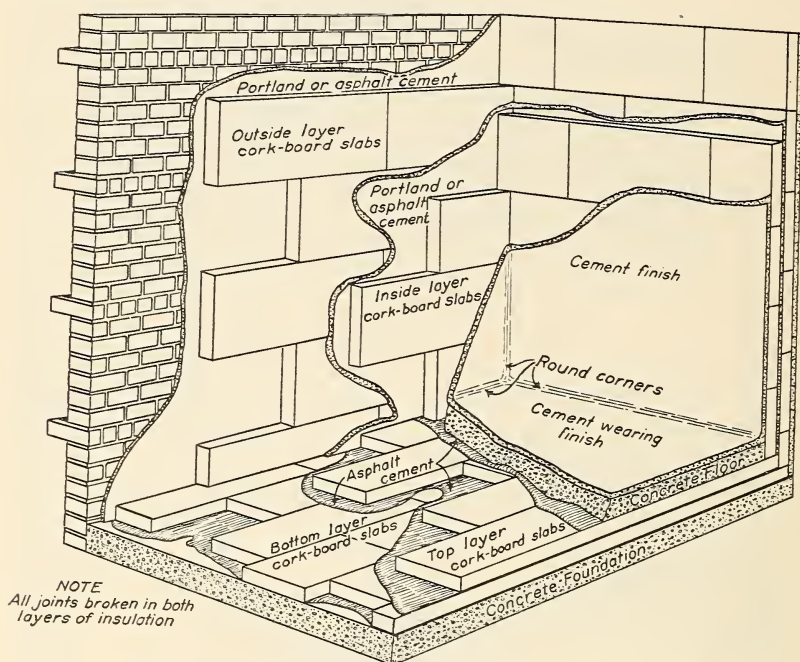


FIGURE 11.—Perspective view showing erection of corkboard slab insulation.  
(Former Bureau of Chemistry.)

## TYPES OF CONSTRUCTION

Practically all modern cold-storage plants are of brick or of reinforced-concrete construction, which gives stability to the structure and renders it fireproof and easy to insulate. Corkboard, embedded in layers of cement mortar, is the type of insulation most in use, all walls, partitions, ceilings, and floors being so insulated. The amount of insulation used depends to a great extent upon the temperature that is desired for the rooms. The freezer rooms require considerably more insulation than the chill rooms. Different thicknesses of corkboard can be purchased to meet all requirements. The standard

size is 1 foot wide by 3 feet long, and the thickness varies from  $\frac{1}{2}$  inch to 6 inches. Partitions separating two storage rooms require less insulation than do the outside walls; likewise floors and ceilings located between storage rooms require less insulation than do the ground floor and top ceiling (figs. 11 and 12).

As a rule no outside windows are used in the storage rooms, and both lighting and ventilation are accomplished artificially. Outside windows, however, if properly installed, are a great aid in renovating and ventilating storage rooms. The doors of the cooler rooms are usually from 6 to 8 inches in thickness, with insulation embedded between the outside panels. These doors should never open directly into the warm atmosphere; anterooms or corridors should be provided, if such openings are necessary. A sufficient number of elevators should be included in the buildings so that delays in unloading trucks and cars can be avoided.

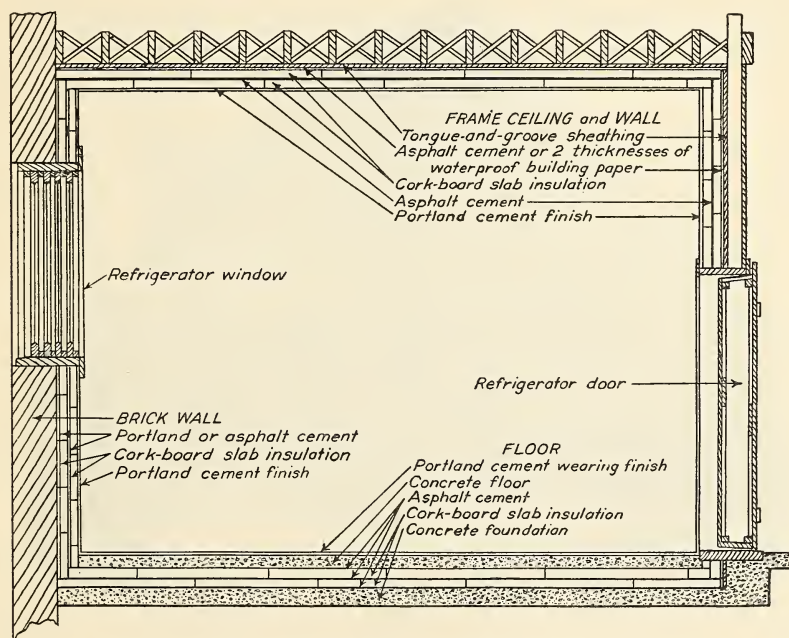


FIGURE 12.—Section showing one method of insulating brick and frame building.  
(Former Bureau of Chemistry.)

Railway trackage running directly into the warehouse should always be obtained if possible, so that cars being loaded or unloaded may be fully protected from direct sunlight or inclement weather (fig. 13).

Teaming platforms should be built within easy access to the street and an overhead cover provided. A receiving platform separated from the loading platform or on opposite sides of the structure will help expedite the handling of the goods and prevent confusion and congestion.

## COST OF CONSTRUCTION

The cost of the warehouse varies in different localities and according to the size, material, and type of construction. Recently built warehouses, of the most modern type, have been erected at a cost ranging from 35 to 41½ cents per gross cubic foot of space enclosed. This includes modern sprinkler equipment and all machinery and insulation, other than portable equipment. The cost of machinery and piping ranges from 3½ to 5 cents per cubic foot of refrigerated space.

Added to the above figures must be the cost of the ground on which the plant is erected and the cost of financing, railway trackage, etc.

In general, the larger the plant, the lower will be the comparative cost of construction and operation.

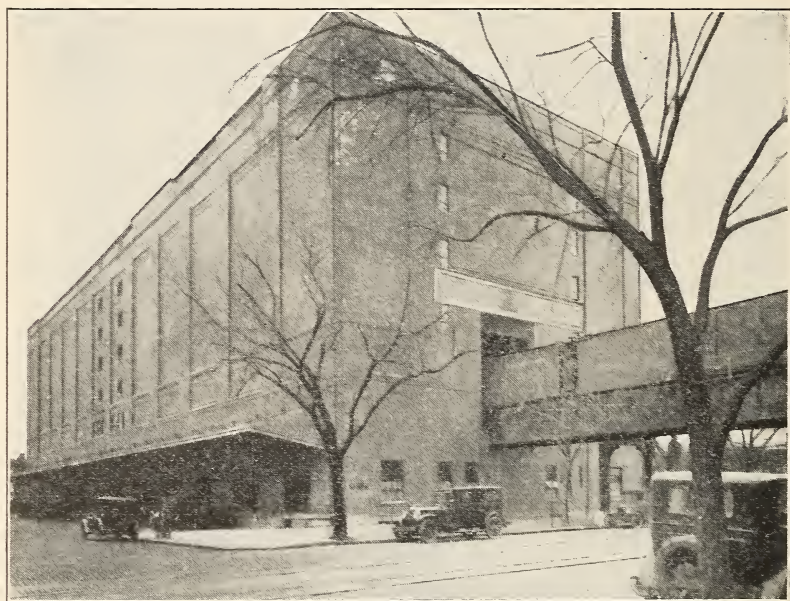


FIGURE 13.—A well-arranged warehouse showing facilities for loading and unloading produce. By means of railway trackage directly into the building and overhead cover at teaming platform, goods can be handled in full protection from inclement weather.

## TEMPERATURE AND HUMIDITY

Most authorities agree on the correct temperatures for storing eggs and poultry, but there is considerable difference of opinion regarding the degree of humidity most desirable for storage rooms.

Eggs should be stored at the lowest temperature at which they can be stored without causing the solidification of the interior of the eggs, for this causes expansion of the contents and cracking of the shell. Eggs with a firm thick albumen freeze at a higher temperature than do thin-bodied watery eggs; likewise strong-bodied, thick-shelled eggs will withstand freezing temperatures better than weak, thin-shelled eggs. According to most warehousemen, all factors considered, the

ideal temperature is 29° F. with never a variation of more than 1° in either direction. Most modern cold storages can hold the temperature within a variation of 3°; in cases in which this is possible, the usual range is from 28° to 31°. Whatever the temperature maintained in the storage room, it should be held as nearly uniform as possible.

The storage of frozen eggs and poultry is much simpler, for although a slight variation of temperature is not desirable, it does not materially affect the solidity or keeping qualities of the product. After the poultry has been taken from the sharp freezer, where it should be held at a temperature from -10° to -20° F. for 48 hours, it can be successfully stored at a temperature near -5° during the entire storage season. Some modern storage houses sharp-freeze at -10° and keep the poultry stored at that temperature during the whole storage period. This seems to produce even better results than sharp freezing at a lower temperature and then storing in a room at -5°.

The problem of humidity is one which each operator is in large measure obliged to solve for himself. Varying climatic conditions, location of the storage house, temperature, and altitude are all important factors to be considered.

Until very recent years it was usually considered desirable to keep the egg-storage room as dry as possible to prevent mold growth forming on the shell of the egg. But recent investigations have disclosed the fact that storage rooms of too low humidity have a harmful effect on the eggs. The moisture of the egg is gradually absorbed by the dry air of the storage room, and the air cells of the eggs become enlarged. The larger the air cell the weaker becomes the egg contents, and deterioration is more easily started. Some warehousemen who at one time were placing pans of calcium chloride or some other moisture-absorbing medium in various parts of their storage rooms have found it beneficial not only to abandon this practice but to place pans of water in the room in an effort to increase the humidity. This is especially true in warehouses in the northwestern part of the United States and in warehouses located in semiarid areas or at higher altitudes.

A humidity held as high as possible but just below the point at which mold growth would form is the most desirable. A recent survey of 20 of the largest storage houses located in various parts of the country shows that 2 were trying to keep their egg rooms as dry as possible, 2 were holding the humidity at 80 percent, 10 at 82 to 85, 2 at 86, 2 at 86 to 90, and 2 at 90 percent.

Several of the warehousemen maintained a higher degree of humidity early in the storage season than later, when a lower humidity (usually varying about 3 points) was maintained. The warehousemen who operate with the higher humidity employed some artificial medium of air circulation in the room at all times (p. 26).

The question of humidity in subfreezing temperatures is one in regard to which there is great need of scientific research. When the air of a storage room is cooled to a subfreezing temperature most of the moisture it contains will be frozen and deposited as ice or frost on the refrigerating coils, and the result will be a dry atmosphere in the storage room. Consequently a room sufficiently cooled to store poultry is of very low relative humidity, and the dry air of the room gradually absorbs the moisture from the poultry and causes dry, scaly

spots known as "freezer burn" or "scald spots" to form on the skin. Many experiments have been undertaken by warehousemen in an effort to raise the humidity of their freezer rooms, but only during recent years has this been accomplished with any degree of success. An atomizing device is now on the market that seems to break down water particles into such a fine fog or mist that the relative humidity is raised in rooms even at subzero temperatures. This higher humidity prevents desiccation of the skin and practically eliminates freezer burn even after several months of storage. When humidifiers are not used, storers of poultry should see that the poultry boxes are carefully lined with moistureproof paper, and all the smaller sized birds, or those with slight fat protection, should be individually wrapped.

The boxes of poultry, after they are removed to the holding room, should be packed tight against each other with as little exposure to the outside air as possible. Currents of air from fans or other circulating mediums should not be thrown directly against the boxes, and if each carcass is not individually wrapped, the paper lining of the boxes should be so arranged that at least a double layer of paper will cover each bird.

#### COLD-STORAGE TARIFF

A general survey of cold storages of various sizes and types throughout the country reveals many different methods for making storage charges, with only a little variation in the rates. Unfortunately for the industry itself, there seem to be no standard charges applicable to storages even of the same type and location.

Competition among different storages in the same city necessitates the granting of practically the same tariff charges if conditions are as good in one as in another, but there are many things the holder should take into consideration beside the rates.

Most important are the facilities the storage has for preserving the products. A cautious shipper is not attracted by cheap storage rates unless he knows that his product will be as well taken care of as it would be at a storage that charges a higher rate. The shipping facilities available, access to good markets, storage-in-transit privileges, and insurance rates are among the factors to be considered.

In the storage of poultry and eggs the general practice among warehousemen is to charge double the regular rate for the first month in order to take care of the expense of unloading cars, clerical help, etc. A few storages, however, charge the regular rate for each month's storage and then make an additional charge for handling. This charge is usually based on time, and ranges from 75 cents to \$1 per man-hour. The same charges apply to produce that is to be loaded into cars for reshipment. Some storages charge a flat rate of from \$5 to \$7 per car; others charge by the actual tonnage handled, usually about 3 cents per 100 pounds. The tariff in most storages is figured by the pound, although some warehousemen feel that a more equitable charge could be made if the tariff were based on the cubic feet of space occupied, rather than on the weight of the package.

Table 2 gives the average charges made by 20 of the larger storage warehouses selected in different parts of the country.

TABLE 2.—*Cold-storage charges on eggs and poultry for specified periods, by quantities and classes, 1937*

| Commodity                                 | Rate of storage |                       |                   |
|-------------------------------------------|-----------------|-----------------------|-------------------|
|                                           | First month     | Each additional month | Season to Dec. 31 |
| Eggs:                                     | <i>Cents</i>    | <i>Cents</i>          | <i>Cents</i>      |
| Per case, in shell:                       |                 |                       |                   |
| Under 50 cases.....                       | 16              | 10                    | 50                |
| 50 to 199.....                            | 15              | 8                     | 45                |
| 200 cases to 9 carlots <sup>1</sup> ..... | 14              | 7                     | 40                |
| 10 carlots and over.....                  | 12              | 6                     | 35                |
| Per 100 pounds:                           |                 |                       |                   |
| Liquid:                                   |                 |                       |                   |
| Less than carlot.....                     | 25              | 10                    | -----             |
| Carlot and over.....                      | 23              | 10                    | -----             |
| Frozen:                                   |                 |                       |                   |
| Less than carlot.....                     | 20              | 10                    | -----             |
| Carlot and over.....                      | 18              | 10                    | -----             |
| Poultry per 100 pounds:                   |                 |                       |                   |
| Unfrozen:                                 |                 |                       |                   |
| Less than 5,000 pounds.....               | 35              | 20                    | -----             |
| 5,000 pounds and over.....                | 30              | 18                    | -----             |
| Frozen:                                   |                 |                       |                   |
| Less than 5,000 pounds.....               | 30              | 20                    | -----             |
| 5,000 pounds and over.....                | 20              | 18                    | -----             |

<sup>1</sup> Standard car contains 400 cases.

On account of the extra labor involved in transferring liquid eggs and unfrozen poultry from the sharp freezer to the holding room, a higher storage rate for products in this condition is charged by most warehousemen. Some storages grant a slightly lower rate on frozen eggs if they are packed in crates of two 30-pound cans each.

Insurance rates on poultry and eggs in storage vary greatly according to the situation and type of construction of the warehouse. In the survey mentioned, it was found that rates ranged from 8 to 60 cents per \$100 per annum. In most modern fireproof warehouses, however, the rate usually is from 12½ to 15 cents per \$100 a year. The common practice is to collect for a year's insurance from the storer, and then rebate for the unexpired time after the product is withdrawn from storage. On request of the holder, some storage companies will insure the holdings by the month, charging a slightly higher rate. The usual charge is from 2 cents per \$100 per month, and a new policy for any goods still remaining in storage is made out each month. The insurance is usually made to cover fire, lightning, windstorm, and sprinkler leakage.

A former practice in computing storage charges, and one that is still followed to some extent, is to grant a season rate of 50 cents per case on shell eggs, which applies from the time the eggs are received at storage until December 31, after which period a regular monthly charge is made. These season charges usually include all expense to the storer, such as handling charges and insurance.

Although the storage rate per pound on poultry is higher than the rate per dozen on eggs, the rate is almost the same if both are figured in terms of weight. Poultry requires a lower temperature than do eggs, which temperature will cost about 50 percent more to maintain, but the cost of maintaining the lower temperature is offset by the fact that the eggs occupy more space in the storage room than does an equal weight of poultry.

## PREPARATION OF SHELL EGGS FOR STORAGE

In spite of the fact that there is considerable danger of breakage in transit, most eggs intended for storage are packed at country packing plants, because a great majority of people who store eggs are not equipped at the terminal warehouses to repack eggs in large enough quantities to fill their requirements. Labor is cheaper in the country, and freight charges are saved on the small, dirty, and otherwise inferior eggs unsuitable for storage.

## REGRADING AND REPACKING

It is impossible to place too much stress on the proper grading and packing of eggs intended for storage. Too frequently eggs are stored in the condition in which they are received from the farm, and financial loss to the holder is almost sure to result.

Eggs should be placed in the chill room (fig. 14) as soon as they are received at the buying stations. There they should be graded and

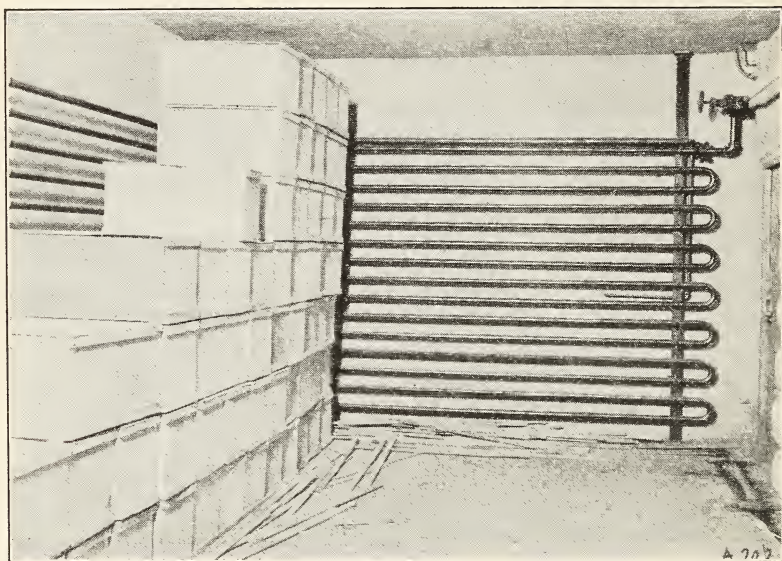


FIGURE 14.—A chill room with a capacity of at least 400 cases of eggs is desirable at country packing plants. At 40° F. the eggs can be satisfactorily held until a carload is accumulated.

repacked and held at a temperature ranging from 40° to 45° F. until they are ready to be shipped to storage. They should never be placed in a cooling room and then taken out and repacked in the warm air, for the moisture that condenses on the shell will cause a dampness that will greatly deteriorate the quality of the egg. It is also bad practice to place eggs in a refrigerator car without pre-cooling, for the temperature of the warm eggs will raise the temperature of the car.

Some egg packers think that the candling of eggs during the early part of the cold-storage season does not justify the expense and time involved. Eggs received in March, April, and the first part of May contain very few spoiled or weak-bodied eggs, except in southern

localities. But they should always be rehandled, eggs of uniform sizes being packed together and soiled or dirty eggs packed separate. As the eggs are rehandled and repacked into the new cases for storage they should be clicked together to detect unsoundness of shell that is not visible without the use of candlers. The usual method is to take three eggs in each hand and click them together by an inward movement of the fingers. A dull sound indicates the presence of cracked shells, which can be readily detected by placing the eggs before a candling light. Even these so-called blind checks should be removed from the eggs going into storage. Cracked eggs should never be placed among the eggs for storage, as they are likely to break in transit and the resulting leakage may cause the surrounding eggs to become moldy.

New cases, fillers, and flats should always be used. Solid, white, pulp fillers and cup flats are rapidly replacing the strawboard material formerly used. The cushion formed by the construction of the cup flat protects the eggs from shocks of rough handling, and considerable breakage is avoided. The pulp from which the material is made is practically odorless, and the egg yolk does not absorb flavor from it as rapidly as from strawboard material.

When strawboard fillers and flats are used they should be made of heavy material; they should be hard finished and perfectly dry. They should weigh between  $3\frac{1}{4}$  and 4 pounds per set of 10 and never weigh less than  $3\frac{1}{2}$  pounds. Excelsior pads, placed at the bottom and top of each compartment of the case, should be used instead of loose excelsior. Sometimes a third pad is placed between the top and second layer, but it is doubtful whether this form of packing is necessary. There is also the added danger in this type of packing of raising the top layer in the case so high that the cover of the case presses too tightly against the eggs, causing breakage.

The eggs should be placed in the fillers with the small end down, so that when the egg white weakens from evaporation the yolk in rising rests against the membrane which forms the lower wall of the air cell. This prevents the yolk from adhering to the shell. Eggs also have a better appearance when the large ends are packed up. The smaller end of the egg is stronger and more able to stand shocks than the larger end.

Eggs that are so long as to project above the filler should never be packed for storage, and extra large eggs either should not be used or should be placed in the corner cells of the fillers.

If eggs are not candled, they should be carefully clicked so that the cracked eggs may be detected. Although this is usually done, experiments have shown that a great many cracked eggs get into the storage-packed cases. Probably more eggs spoil in storage because cracked eggs are packed with them than for any other reason.

Opinions differ as to the harmful effect of washing eggs that are to be placed in storage. It is true that washed eggs deteriorate much more rapidly when held at summer temperatures than do unwashed eggs, but some authorities claim that if eggs are thoroughly dried and put in storage as soon as washed the results will be much more satisfactory than if they are stored as dirties. Until more definite experiments have been made it would seem advisable to use considerable caution in storing washed eggs.

### LOADING AND ICING REFRIGERATOR CARS

As soon as possible after the eggs are packed they should be loaded into refrigerator cars and shipped to storage. The cases should be loaded lengthwise, on racks, to permit free circulation of the cold air in the car. The best method of loading is to begin at both ends of the car and load toward the center. Any space left in the center of the car should be solidly packed with straw, or if enough space is available, wooden racks, properly braced, should be placed between the two stacks. Straw should never be used in the ends of the car near the ice bunkers.

The cars should be iced long enough before the eggs are loaded so that the temperature is at least as low as 40° F. The eggs should be prechilled and taken from the cooler and immediately loaded into the car.

If they are not chilled before they are loaded, the warm cases will tend to raise the temperature of the car, and the eggs will be slow in cooling, especially those packed in the center.

### PREPARATION OF FROZEN AND DRIED EGGS FOR STORAGE

In the spring of the year, during the heavy egg-packing season, there are always many undersized, dirty, and cracked eggs on the market. The shipping of these eggs to terminal markets would result in heavy financial loss to the packers. To take care of this situation many egg packers break the eggs from the shell and freeze them, or ship them to nearby egg-breaking establishments, where they are broken and packed. The frozen-egg industry has grown to enormous size in the last several years (fig. 5), and the demand for frozen eggs has been so great that dealers now find it profitable to break high-grade eggs from current receipts for their frozen supply. The high-grade product now usually found on the market is largely responsible for the increased use by the bakeries or other consumers of the frozen product.

The preparation for frozen and for dried eggs, up to a certain point, is practically the same. The eggs to be used are first carefully candled, and all the spoiled eggs that can be detected are removed. The breaking rooms are light and sanitary, and all utensils are frequently sterilized. Each egg is broken into a cup, and is thoroughly observed by sight and smell. The liquid egg is then placed in a churn to be thoroughly mixed with other liquid eggs, and then frozen in cans containing about 30 pounds of the liquid. The white and yolks may be mixed together or may be kept separate. The cans are then placed in a sharp freezer with a temperature below zero, and are frozen solid. As the freezing causes expansion of the liquid, the cans are filled only to within a few inches of the top. After the liquid is frozen, enough additional liquid is poured in to fill the cans, which are again returned to the sharp freezer and frozen solid. They may then be removed to a temperature from 0° to 5° F., at which they may be held until sold.

If sufficiently cold temperature is available, or if cans can be placed directly against the refrigerator coils, the expansion of the liquid does not occur and the cans may be filled at the first pouring and the extra labor of repouring avoided.

Dried whole eggs and yolks are usually prepared by spraying the liquid in a high-ceilinged chamber heated to a temperature of 160° to 170° F. The spray dries and forms a powder as it descends to the floor and is then packed in containers and is ready for market. Whites alone do not spray so easily. They are usually prepared by drying in

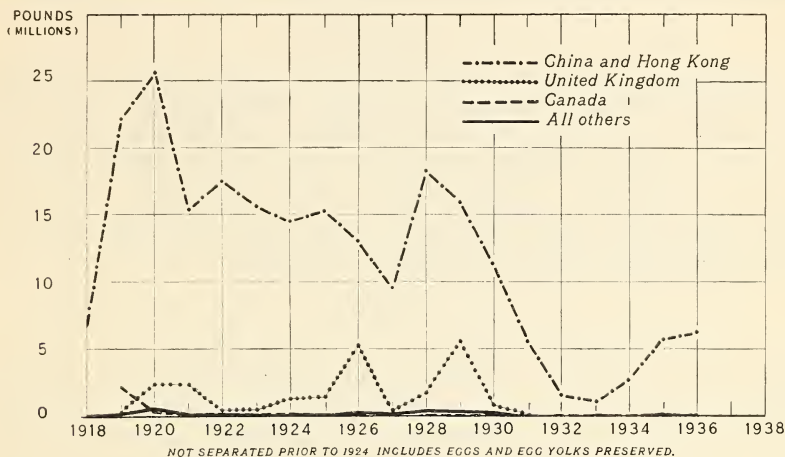


FIGURE 15.—UNITED STATES IMPORTS, BY COUNTRIES, OF DRIED AND FROZEN EGGS, YEARS ENDED JUNE 30, 1918-36.

Not separated prior to 1924; includes eggs and egg yolks preserved. The imports from China far exceed the imports from all other countries.

metal pans. The product is then scraped off and is sold as albumen. The dried product is usually kept in coolers but will keep for a considerable length of time in ordinary temperatures (fig. 15).

The importation of dried and flaked eggs from China at a cost lower than that at which they can be manufactured in this country has caused many of the American egg packers to abandon the practice of egg drying.

## PREPARATION OF POULTRY FOR STORAGE

### FEEDING BEFORE KILLING

The proper feeding of the poultry before it is killed is one of the most important factors in obtaining high-grade storage-packed stock. Hens can be fed a fattening ration softened with liquid buttermilk for a period of 6 to 8 days, to good advantage. The gain in weight pays for the cost of the feed in most cases, but the big advantage lies in the improvement of the flesh. Young chickens gain in weight much more rapidly than do old hens, and can be fed from 8 to 10 days with good results if in a healthy condition. Gains during these periods should average from 5 to 15 percent in the weight of hens and from 15 to 35 percent in chickens.

Poultry intended for shipment alive should not be fattened, for the intensive feeding, coupled with the close confinement in the feeding batteries, rapidly breaks down the vitality of the birds, and considerable losses from death and disease are likely to occur. Little advantage is to be gained in fattening roosters, ducks, geese, and turkeys by the battery method.

For 18 hours before being killed poultry should not be fed, but water should be constantly before them during that time. This will insure empty crops, and the entrails will be flushed as well.

Great care should be exercised in removing poultry from feeding batteries as they are easily torn and bruised, especially those that have been milk-fed for a considerable period.

#### KILLING

Before being killed, the birds should be hung by their feet, heads downward, to insure complete bleeding. The jugular vein in the neck is cut first, and the brain is then pierced with a sharp knife, the blade passing through the opening in the roof of the mouth, and on into the brain. Poultry that has been improperly bled has a dark reddened skin, especially on the hips and wing tips, which not only detracts from the appearance of the bird but causes it to spoil more rapidly than one that has been well bled.

#### SCALDING

If poultry is scalded it should be immersed in water at a temperature from 160° to 170° F. and should remain there only until the feathers will rub off easily. Too long a scalding or too hot water will tend to cook the skin and lower the keeping quality of the bird. If the head and feet are not immersed in the scalding water the carcass will have a much better appearance than if it is completely dipped.

As soon as the feathers have been removed, the carcass should again be placed in water of the same temperature as that used in scalding, and then quickly removed and placed in clean, cold, running tap water (but it should not be iced). This causes the bird to puff or plump and gives it a much better appearance. Poultry should be left in the cold water for 3 or 4 hours and then taken out and placed in ice water or hung in a cooler until the inside temperature of the heaviest fowl is reduced at least to 35° F. The skin of water-chilled poultry that has not been thoroughly dried shows deterioration a short time after storing. Small spots of dry, scaly skin will be noticeable and the carcass will have the appearance of being blistered. This is especially true of scalded poultry, as the protective qualities of the skin are greatly reduced by the hot water.

#### SEMISCALDING

A method of dressing poultry, known as semiscalding, has been practiced during recent years by some of the largest poultry packers. This process is practically the same as scalding, except that the temperature of the water used is much lower, ranging from 126° to 130° F. The birds are immersed for a period of 30 to 35 seconds. The feathers are picked off, instead of being rubbed off as in the case of scalded poultry, and a result is obtained that resembles dry picking. It has the advantage over dry picking, in that it is a much quicker method and removes many pin feathers that could not be removed without this partial scalding. Poultry plucked by this method should be thoroughly dried before being frozen, or mold growth is likely to occur. But if proper precautions are taken such poultry seems to keep in storage as well as that plucked by the dry method.

### DRY PICKING

When the birds are to be dry-picked, that is when the feathers are to be removed without the use of hot water or steam, they should be removed as soon as the brain is pierced or they will "set" and a poor picking job will result.

Dry-picked poultry should be dry-cooled where refrigerator facilities permit. As soon as the feathers are removed the birds should be hung on chilling racks, head downward, legs well spread, and bodies not touching. They should be allowed to hang in a chill room as near freezing as possible, but not lower than 32° F., for at least 24 hours before being packed. Oscillating fans can be used to hasten the drying process (fig. 16).

### FULL-DRAWN POULTRY

A method of marketing poultry by preparing it full-drawn has come into considerable use during the last few years. After the poultry is dressed at the poultry plant, the head, feet, and entrails are removed. The giblets are cleaned, wrapped in parchment or waxed paper, and replaced in the body cavity. The entire carcass is frozen by a quick-freezing process as soon as it is prepared, and is marketed in a frozen state. A saving in freight is accomplished by removal of the inedible portions at the country point and the saving in containers and storage charges are important items. Proponents of this method claim that the poultry meat is sweeter and finer flavored than is the case when poultry is shipped without the removal of the entrails.

If the carcass is hard-frozen immediately after being prepared, and if well wrapped in moisture-proof paper, the keeping qualities in storage seem to compare favorably with that of undrawn poultry.

### GRADING AND PACKING

Great care should be taken in the grading and packing. Birds of one color, size, and quality, and as nearly uniform in appearance as possible, should be packed together. Wooden boxes are the most desirable packages for dressed poultry. A good quality of new lumber, free from odors, and of sufficient strength to carry poultry is good condition, should always be used. The poultry trade prefers birds packed 12 to the box, breast up, in single-layer boxes, excepting the larger chickens and turkeys, which are sometimes packed on one side. The single-layer boxes permit freer circulation of air, freezing is accomplished quicker, and carcasses retain their shape better than when double-layer boxes are used.

Heavy turkeys are sometimes packed in double-layer boxes or barrels. If single-layer boxes are used, the turkeys are usually packed six to the box.

All boxes and barrels should be properly lined with a good quality of white parchment paper, and all heads wrapped in water-finish fiber paper (fig. 16). On account of the tenderness of the skin of the broilers, it is also desirable to wrap the bodies in parchment or waxed paper. If barrels are used, a good grade of absorbent paper should be placed between the layers of poultry.

## FREEZING

After the birds have been placed in the boxes, the tops are nailed on, and the boxes placed bottom up in the freezer. This has a tendency to flatten the breast and adds greatly to the appearance of the bird. The boxes should be loosely stacked, or staggered, one end of the box resting on another in such a way as to permit free circulation of cold air around each box. In the larger storages, the same results are obtained with much less labor by placing  $\frac{3}{8}$ -inch slats between the boxes, and then removing them after the contents are thoroughly frozen.



FIGURE 16.—Wrapping the heads after they are dried. Rapidly revolving fans can be used to advantage in drying poultry.

The temperature of the sharp freezer should be at least  $-10^{\circ}$  F. Poultry should remain there until it is thoroughly frozen, and should then be removed to the permanent storage, where it should be stored in as low a temperature as possible, at least below zero, and preferably at the same temperature as the sharp freezer.

If the poultry is not to be stored at the packing point, it should be loaded into refrigerator cars as soon as it is thoroughly chilled or frozen, and it should be shipped immediately. The car should be well iced, with 10 to 15 percent of salt added, which will keep the temperature near the freezing point. The salt and ice should be placed in the car at least 12 hours before the poultry is loaded. Racks are usually part of the equipment of the cars. Under no condition should the poultry be placed in the bottom of the car flat against the floor, as this prevents the free circulation of cold air.

The lower part of the car is usually  $5^{\circ}$  to  $10^{\circ}$  cooler than the upper part, and it is therefore not desirable to pack the car more than three-fourths of the distance to the top.

If it is necessary to pack eggs and poultry together, as is often true in the smaller dressing plants, the poultry should always be packed nearest the ice bunkers and the eggs in the center of the car. Eggs are likely to freeze in heavily salted iced cars if placed near the ends or bottom of the car.

### SHIPPING AND STORING

#### MAKING SHIPMENT TO STORAGE

Before shipping eggs or poultry to storage, the shipper should obtain a schedule from the warehouse showing the rates of storage, insurance and handling charges, switching charges, etc. If he wishes to borrow money on his holdings he should also ascertain the amount that will be advanced on his particular grade of produce. Usually a storage house will advance the money or will negotiate the loan free of charge at its bank. From 70 to 80 percent of the market value of the goods can usually be borrowed, the storage company holding the negotiable warehouse receipt as security for the loan.

In shipping a car of produce to storage the owner should consign the car to himself in care of the storage company. The bill of lading should be immediately forwarded to the storage company, together with instructions regarding the handling and loan, and with any other information the warehouseman may need.

A complete invoice showing the different lots and classes in each car should also be immediately forwarded to the warehouse. This is especially important in the case of mixed cars of poultry. The United States Department of Agriculture publishes each month a report that shows the different classes of poultry being held in storage in the important warehouses of the country. The different classes are reported separately, such as broilers, fryers, roasters, etc. Unless the warehouseman has the information from the shipper, it will be necessary for him to sort out these classes himself or, as is usually the case, he will report the entire lot under the heading of miscellaneous poultry, which leads to insufficient and sometimes misleading reports.

#### PLACING PRODUCTS IN STORAGE ROOMS

As soon as the goods arrive at the terminal storage they should be unloaded and placed in rooms of the proper temperature.

#### STORING EGGS

Eggs should always be stored in a separate room to insure freedom from absorption of objectionable odors from other products.

The cases of eggs should be piled in the room in such a way as to permit free circulation of air in every part. An empty space, at least 10 inches below the lowest beam support of the ceiling, should be maintained over the entire room. The cases should not be packed tight into the corners of the room. Quarter-inch or half-inch slats should be placed between the layers of cases to permit free circulation of air. Each separate lot should be stacked so that easy access can be had thereto by the attendants when withdrawing cases from any of the lots. Two- by four-inch planks, or racks of the same height,

should be placed on the floor so the air can easily circulate under the bottom cases (fig. 17).

If a person or firm that stores eggs wishes later to make partial withdrawals of a certain lot of goods, the warehouse can be saved a great deal of trouble and expense by having the different grades stored under separate lot numbers. Much of the expense connected with the operation of a cold storage occurs in placing in and taking from the storage room the different commodities. This is partly covered by the handling charges that most cold storages include in their tariff, but when only small lots of eggs are withdrawn at a time, or when certain grades or weights of poultry must be sorted out by the attendant, these handling charges may not be sufficient to cover the actual expense involved. It takes practically the same length of time to



FIGURE 17.—A well-packed egg room. The cases are stacked on racks, and slats are placed between the cases. Aisles are wide and are arranged directly beneath the brine pipes.

withdraw 1 case of eggs as it does to withdraw 10 or 20, and the expense involved in making these small deliveries amounts to thousands of dollars each year in the larger warehouses. If poultry were stored in lots according to weight and grade, and if dealers would use more consideration in the withdrawal of eggs, a great saving to the industry would be accomplished.

#### VENTILATION OF STORAGE ROOMS

Regardless of what degree of humidity is maintained in the room, the air should be kept constantly in circulation, or "air pockets" will occur in various places, and a package odor or even moldy eggs will result. If the refrigerating coils are properly placed near the

ceiling of the room and the eggs are properly piled, a natural circulation of air will be maintained, for as the colder air near the pipes is denser than the warmer air of the room, it moves down to the floor, causing the warmer air to rise to the coils where the heat will again be absorbed, and the same process will be repeated. Revolving electric fans can sometimes be used to advantage if they are placed in corners of the room, but care should be taken that the air is not blown directly against the cases. When the indirect cooling system is used, fans that revolve at high speed blow the air over the cooling pipes and then on to the storage room.

The use of ozone machines to absorb foreign odors from the egg rooms has become a general practice. Even 10 years ago a survey showed that 86 percent of the larger storage houses in the country were using ozone machines, and most of them reported favorable results. There seems to be especial need for some such deodorizing machine in any egg rooms that are used for the storage of fruits or other produce when not in use for eggs. Even when the egg rooms are not so used, some warehousemen believe that the odors from the egg cases and packing materials will be decreased by the use of these machines, though to just what extent this will benefit the eggs has not been determined.

Only a small number of the operators who were using ozone machines reported continuous use of them throughout the entire egg-storage season. Some confine the use of these machines to the first 2 or 3 months after the eggs are stored. In the majority of instances, the machines were used at frequent intervals throughout the year.

Most warehousemen believe that ventilation of the storage rooms, other than the ventilation caused by the passing in and out of the attendants in the performance of their usual duties, is unnecessary. Some of the storage owners have constructed elaborate ventilating systems for their storage rooms, but most warehousemen are agreed that the results obtained from them do not justify the expense.

Cleanliness is an essential factor in the successful operation of a cold-storage plant. The egg rooms should be thoroughly cleaned and renovated between storage seasons. Walls and floors should be thoroughly scrubbed and then sprayed with a solution of cold-water paint, hygroscopic salt, or ordinary whitewash. Too often the impression prevails that the cold air of the egg room prevents bacterial growth. Unused portions of the rooms may be cluttered with an accumulation of old egg cases, fillers, and flats, and broken eggs are sometimes allowed to dry and decompose on the floors. As a matter of fact the cold air retards but does not prevent bacterial growth, and great care should be exercised to keep the rooms sweet and clean.

#### STORING POULTRY

In poultry that is packed and frozen dry there is very little danger that mold growth will form in the holding rooms. The low temperature necessary to the successful storage of poultry prevents the moisture in the air that allows such action to take place. It has, therefore, been found desirable in most instances, after the boxes of poultry have been thoroughly frozen, to pack them tight against each other, so that the dry air will have as little chance as possible to absorb the moisture from the poultry meat.

The maintenance of an even temperature in the storage rooms is of the utmost importance if the stored goods are to be properly preserved. With the modern machinery with which most of the warehouses are now equipped the problem is not so difficult as it was formerly. More than 2° or 3° variation in temperature should be avoided if best results are to be secured. With proper care, the warehouseman will have little difficulty in maintaining a temperature within this variation.

#### PREPARATION OF REFRIGERATOR GOODS FOR MARKET

Both eggs and poultry that have been held in cold storage depreciate after removal somewhat more rapidly than when marketed fresh, but not so rapidly that they cannot be placed in the hands of consumers in a sound and wholesome condition.

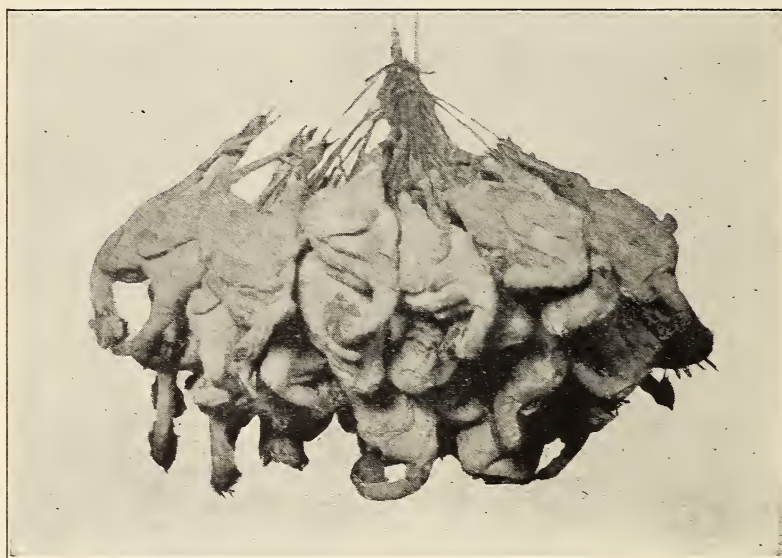


FIGURE 18.—A hook of frozen poultry just out of cold storage.

#### RE candling EGGS

Storage eggs should always be candled before they go to the retailer, even though they were carefully candled before they were stored. If they were properly prepared, the loss will be very slight even after 8 or 9 months' storage, but one bad egg to the consumer will do more harm than the saving in the cost of recandling would justify. The eggs should always be placed in the ice box in the retail store, and again in the ice box after they have been bought by the consumer. Only a few days' supply of storage eggs should be bought at a time, and they should be marketed as rapidly as business practice will permit.

## DEFROSTING POULTRY AND FROZEN EGGS

Scalded poultry deteriorates more quickly than does the dry-picked, and should be handled and marketed with care and dispatch. It is sometimes thawed by being immersed in running cold water. The length of time required varies from 8 to 12 hours, according to the size of the fowl and temperature of the water. Soaking in water prevents the dry and chafed appearance of the skin, but it also tends to lower the keeping quality and destroys much of the good flavor of the chicken. A better method of thawing for both dry-picked and scalded poultry is to hang the carcass by the legs in an ordinary ice box. As the poultry thaws it straightens and resumes its natural shape. It

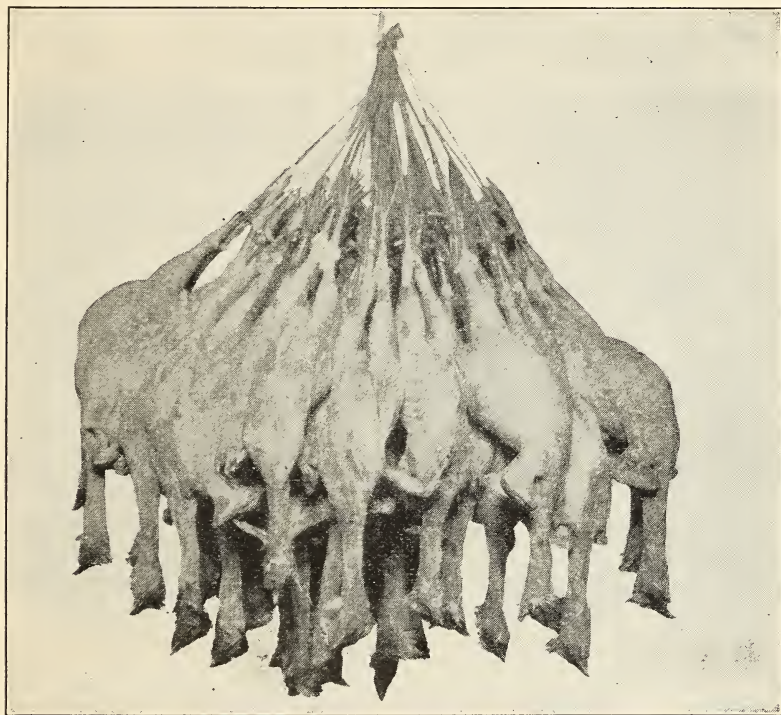


FIGURE 19.—The same hook of poultry shown in figure 18 after hanging overnight in ordinary room temperature. The poultry has resumed its natural shape and has not been damaged by water.

can usually be thawed by being hung in the ice box overnight (figs. 18 and 19).

The best method of marketing storage poultry is to deliver it to the housewife while it is still hard-frozen. It will keep wholesome for a considerable length of time while in this condition and enable her to prepare it for cooking as soon as it is defrosted and before bacterial infection develops. It is difficult, however, to remove the entrails of frozen poultry and as most of the poultry must be so prepared, the consuming public must receive instruction and information on the subject before much progress can be made in this form of marketing. It, therefore, falls to the lot of the retail merchant more

than to anyone else to see that the stock is delivered in as sound condition as possible.

Refrigerator show cases, as a means of displaying hygienically and at the same time preserving the flesh, aid in solving this problem. Not only can the product be better displayed and preserved but bacterial invasion from the outside air is reduced to a minimum (figs. 20 and 21).

Frozen eggs must be used soon after they thaw, or spoilage is sure to result. Some bakers avoid spoilage by placing the egg cans in running water and allowing them to stand overnight before being used. This is perhaps the most satisfactory method, although they can be thawed by simply letting them stand in a warm room until all frost is removed. Only such quantity should be thawed as will be used immediately; should any portion be left over, it should be placed in a refrigerator and used the following day.



FIGURE 20.—An attractive poultry display, but no facilities are provided for sanitation or refrigeration.

#### WHOLESOMENESS AND PALATABILITY OF STORAGE EGGS AND POULTRY

According to extensive research made by the former Bureau of Chemistry of the United States Department of Agriculture,<sup>1</sup> both eggs and poultry can be stored for a period from 9 to 12 months without excessive loss in flavor, and for much longer periods without material loss in food value or general wholesomeness.

Experiments made with several hundred chickens showed that there was greater deterioration in a fresh-dressed chicken after 2 days' holding in the housewife's ice box than there was in a properly prepared storage chicken that had been frozen for 8 months. Even at the end of 12 months in the freezer the deterioration is frequently less than that which has occurred in the fresh-dressed chicken that

<sup>1</sup> FRANKLIN, I. C. THE SERVICE OF COLD STORAGE IN THE CONSERVATION OF FOODSTUFFS. U. S. Dept. Agr. Yearbook 1917: 363-370, illus. 1918.

has gone promptly from the producer to the consumer but that has not been kept constantly at a temperature below 40° F.

The most experienced poultryman will have difficulty in detecting by taste, the difference between fresh-dressed poultry and that which has been stored for 5 or 6 months and then properly thawed. A strong or slightly bitter taste begins to develop in the meat near the bone and interior of the chicken after that time. After 8 or 9 months' storage the bones begin to darken in color and the flesh begins to lose its sweet natural flavor and juiciness. After more than a year's storage the flesh becomes dry and tasteless, and a more or less strong odor develops because of the rancidity of the fat.

Dry-picked poultry that has been dry-chilled and thawed without the use of water remains in a sound condition much longer than does poultry that has been scalded or thawed in water.

Under usual conditions the storage flavor of the egg begins to develop about 3 or 4 months after storage. It is noticeable only in the



FIGURE 21.—A modern showcase for displaying poultry. The stock is kept clean and sanitary and refrigeration is provided.

yolk and is hard to detect until after 4 or 5 months' storage. Much of the storage flavor developed is probably due to the absorption of odors from the storage room or the packing material of the case. For this reason eggs that have been shell-treated previous to storage, by immersion in an odorless mineral oil, do not develop the storage taste nearly so rapidly as eggs not so treated. The processed or shell-treated egg is coming more and more into favor among packers and consumers, and the extra cost involved in so treating eggs is well justified by the improvement in their quality over the ordinary storage egg.

#### INVESTIGATIONS IN COMMERCIAL PRESERVATION OF EGGS BY COLD STORAGE

To determine the changes and losses that occur during the storage of eggs in a commercial way, the Bureau of Chemistry conducted a

series of investigations and experiments in that phase of the industry, the results of which were published in 1919.<sup>2</sup> Nine separate investigations were conducted, and the following phases of the problem were studied:

The effect of condition of shell upon preservation.

The relation of quality to preservation.

The relation of month of storage to preservation.

The condition of commercially packed eggs as stored.

Types of bad eggs found after storage.

The relation of spoilage in commercially packed eggs and spoilage in specially packed eggs.

Shrinkage of eggs in storage.

Physical and chemical changes in eggs during storage.

Absorption of foreign flavors during storage.

The investigations were made with 841 cases of eggs containing 30 dozen each, and packed in the Middle Western States. The eggs were carefully candled and packed and then shipped to eastern cold storages. They were again candled at the terminals before being placed in storage. At regular intervals during the holding season the different lots were taken out and inspected. This was continued to the end of the storage season, and the following results were obtained.

#### EFFECT OF CONDITION OF SHELL UPON PRESERVATION

Losses in commercial fresh eggs with clean, sound shells were found to be negligible during a storage period of 11 months. In the experiment reported in table 3, the number of bad eggs detected by candling and breaking did not amount to more than 5 per case at any time during the storage period. The principal types of bad eggs found were green whites, crusted yolks, moldy eggs, mixed rots, and white rots (table 4). The first two types are characteristic of washed eggs that have been stored. Unfortunately it is not possible to detect all washed eggs by inspecting the shells before the eggs are stored.

TABLE 3.—*Condition of the shell of fresh eggs affecting preservation in storage, by month of withdrawal*

| Month of withdrawal | Clean, sound shells |                   |          | Dirty, sound shells |                   |          |
|---------------------|---------------------|-------------------|----------|---------------------|-------------------|----------|
|                     | Eggs observed       | Bad eggs per case |          | Eggs observed       | Bad eggs per case |          |
|                     |                     | Candling          | Breaking |                     | Candling          | Breaking |
|                     | Number              | Number            | Number   | Number              | Number            | Number   |
| April.....          |                     |                   |          | 360                 | 0                 | 11       |
| May.....            | 1,026               | 0                 | 0.5      |                     |                   |          |
| June.....           |                     |                   |          |                     |                   |          |
| July.....           |                     |                   |          |                     |                   |          |
| August.....         |                     |                   |          | 359                 | 9                 | 16       |
| September.....      | 710                 | 0                 | 2.5      | 355                 | 16                | 15       |
| October.....        | 704                 | 1                 | 1.5      | 354                 | 12                | 22.5     |
| November.....       | 695                 | 0.5               | 2        | 353                 | 21                | 13.5     |
| December.....       | 709                 | 0.5               | 1        | 357                 | 15                | 21       |
| January.....        | 694                 | 0                 | 2.5      | 358                 | 18                | 29       |
| February.....       | 715                 | 1                 | 2        | 355                 | 30                | 10.5     |
| March.....          | 717                 | 2.5               | 2.5      | 358                 | 24                | 17       |

<sup>2</sup> These data were taken directly from the following publication, which is now out of print and is superseded by this circular: JENKINS, M. K. COMMERCIAL PRESERVATION OF EGGS BY COLD STORAGE. U. S. Dept. Agr. Bull. 775, 36 pp., illus. 1919.

TABLE 3.—*Condition of the shell of fresh eggs affecting preservation in storage, by month of withdrawal—Continued*

| Month of withdrawal | Clean, cracked shells |                   |          | Dirty, cracked shells |                               |
|---------------------|-----------------------|-------------------|----------|-----------------------|-------------------------------|
|                     | Eggs observed         | Bad eggs per case |          | Eggs observed         | Bad eggs per case by candling |
|                     |                       | Candling          | Breaking |                       |                               |
|                     | Number                | Number            | Number   | Number                | Number                        |
| April.....          | 59                    | 0                 | 12       | 86                    | 0                             |
| May.....            |                       |                   |          |                       |                               |
| June.....           |                       |                   |          | 50                    | 0                             |
| July.....           |                       |                   |          | 80                    | 22.5                          |
| August.....         | 49                    | 22                | 7.5      | 104                   | 36                            |
| September.....      | 81                    | 26.5              | 17.5     | 158                   | 71.5                          |
| October.....        | 58                    | 87                | 18.5     | 65                    | 160                           |
| November.....       | 73                    | 108               | 10       | 114                   | 109                           |
| December.....       | 85                    | 84                | 21       | 82                    | 211                           |
| January.....        | 60                    | 132               | 12       |                       |                               |
| February.....       | 82                    | 92.5              | 21       | 91                    | 224                           |
| March.....          | 45                    | 136               | 8        |                       |                               |

TABLE 4.—*Variety of bad eggs developing during storage in eggs with sound shells sorted from commercial refrigerators*<sup>1</sup>

| Item               | April Firsts |                  | May Firsts |                  | June Firsts |                  | July Firsts |                  |
|--------------------|--------------|------------------|------------|------------------|-------------|------------------|-------------|------------------|
|                    | Bad eggs     | Percent of total | Bad eggs   | Percent of total | Bad eggs    | Percent of total | Bad eggs    | Percent of total |
| Found by candling: | Number       |                  | Number     |                  | Number      |                  | Number      |                  |
| Mixed rots.....    | 50           | 25.38            | 57         | 25.22            | 154         | 44.90            | 388         | 52.65            |
| White rots.....    | 20           | 10.15            | 33         | 14.60            | 42          | 12.25            | 125         | 16.96            |
| Black rots.....    | 13           | 6.60             | 29         | 12.83            | 19          | 5.54             | 38          | 5.16             |
| Moldy.....         | 88           | 44.67            | 72         | 31.86            | 93          | 27.11            | 138         | 18.72            |
| Crusted yolks..... | 25           | 12.69            | 34         | 15.05            | 34          | 9.91             | 47          | 6.38             |
| Bloody whites..... | 1            | 0.51             | 1          | 0.44             | 1           | 0.29             | 1           | 0.13             |
| Total.....         | 197          | 100.00           | 226        | 100.00           | 343         | 100.00           | 737         | 100.00           |
| Found by breaking: |              |                  |            |                  |             |                  |             |                  |
| Green whites.....  | 41           | 53.25            | 61         | 42.66            | 88          | 31.77            | 83          | 30.97            |
| Bad odor.....      | 4            | 5.19             | 15         | 10.49            | 18          | 6.50             | 15          | 5.60             |
| Mixed rots.....    | 14           | 18.18            | 49         | 34.26            | 133         | 48.01            | 143         | 53.36            |
| White rots.....    | 1            | 1.30             | 1          | 0.70             | 2           | 0.72             |             |                  |
| Moldy.....         | 2            | 2.60             | 4          | 2.80             | 21          | 7.58             | 3           | 1.12             |
| Crusted yolks..... | 15           | 19.48            | 12         | 8.39             | 15          | 5.42             | 23          | 8.58             |
| Bloody whites..... |              |                  | 1          | 0.70             |             |                  | 1           | 0.37             |
| Total.....         | 77           | 100.00           | 143        | 100.00           | 277         | 100.00           | 268         | 100.00           |

| Item               | April dirty eggs |                  | May dirty eggs |                  | June dirty eggs |                  | June Seconds |                  | July Seconds |                  |
|--------------------|------------------|------------------|----------------|------------------|-----------------|------------------|--------------|------------------|--------------|------------------|
|                    | Bad eggs         | Percent of total | Bad eggs       | Percent of total | Bad eggs        | Percent of total | Bad eggs     | Percent of total | Bad eggs     | Percent of total |
| Found by candling: | Number           |                  | Number         |                  | Number          |                  | Number       |                  | Number       |                  |
| Mixed rots.....    | 19               | 7.20             | 66             | 11.32            | 163             | 40.95            | 130          | 33.00            | 125          | 40.45            |
| White rots.....    | 24               | 9.09             | 57             | 9.78             | 46              | 11.56            | 70           | 17.77            | 30           | 9.71             |
| Black rots.....    | 34               | 12.88            | 182            | 31.22            | 22              | 5.53             | 30           | 7.61             | 14           | 4.53             |
| Moldy.....         | 140              | 53.03            | 177            | 30.36            | 129             | 32.41            | 122          | 30.96            | 110          | 35.60            |
| Crusted yolks..... | 45               | 17.04            | 101            | 17.32            | 38              | 9.55             | 42           | 10.66            | 30           | 9.71             |
| Bloody whites..... | 2                | 0.76             |                |                  |                 |                  |              |                  |              |                  |
| Total.....         | 264              | 100.00           | 583            | 100.00           | 398             | 100.00           | 394          | 100.00           | 309          | 100.00           |
| Found by breaking: |                  |                  |                |                  |                 |                  |              |                  |              |                  |
| Green whites.....  | 20               | 33.33            | 43             | 23.37            | 100             | 51.55            | 74           | 23.12            | 65           | 28.51            |
| Bad odor.....      | 12               | 20.00            | 34             | 18.48            | 12              | 6.19             | 57           | 17.81            | 12           | 5.26             |
| Mixed rots.....    | 7                | 11.67            | 48             | 26.09            | 61              | 31.44            | 167          | 52.19            | 124          | 54.39            |
| White rots.....    | 7                | 11.67            | 7              | 3.80             | 1               | 0.51             | 6            | 1.88             |              |                  |
| Moldy.....         |                  |                  | 3              | 1.63             |                 |                  | 8            | 2.50             | 6            | 2.63             |
| Crusted yolks..... | 14               | 23.33            | 49             | 26.63            | 20              | 10.31            | 8            | 2.50             | 21           | 9.21             |
| Bloody whites..... |                  |                  |                |                  |                 |                  |              |                  |              |                  |
| Total.....         | 60               | 100.00           | 184            | 100.00           | 194             | 100.00           | 320          | 100.00           | 228          | 100.00           |

<sup>1</sup> Data from cases of eggs withdrawn from storage from November to March.

If the shell of a fresh egg is dirty its liability to spoilage during the time it is held in cold storage is markedly increased. In monthly withdrawals made from September to March, inclusive, from a typical lot stored in April, 12 to 30 bad eggs per case were detected by candling, and 10.5 to 29 additional bad eggs were detected by breaking (table 3). Commercial dirty eggs include eggs soiled with feces, mud, and blood, as well as stained eggs showing evidence of having been washed or of having come in contact with the wet, muddy feet of hens, or with wet nests. Bacteria and molds can penetrate wet shells, even though unbroken, and cause the egg to rot. Moldy eggs, green whites, crusted yolks, mixed rots, white rots, and black rots are the principal varieties of bad eggs found among dirty refrigerator eggs (table 4).

It is generally known that eggs with damaged shells do not keep well in storage. This is strikingly shown in table 3. The most common form of deterioration of the cracked egg is molding, which, in stocks stored in the spring, becomes pronounced in September and October and increases throughout the storage period (table 5). The number of bad eggs developing in cracked eggs stored in April and May, as found by candling and breaking, ranged from 44 per case in September to 144 per case in March. If the shells were dirty in addition to being cracked, the losses were greater, amounting in eggs stored in April and held until December to as many as 211 to the case, as found by candling (table 3). These observations were made on damaged eggs present in first-grade commercial packages through oversight or carelessness during the initial sorting of the eggs for storage. The losses found would have been higher had the observations been made on cases containing only cracked eggs, for the mold growing on one egg readily spreads to other broken eggs (fig. 22).

TABLE 5.—Variety of bad eggs developing during storage in eggs with cracked shells sorted from commercial refrigerators <sup>1</sup>

| Item               | April Firsts  |                  | May Firsts    |                  | June Firsts   |                  | July Firsts   |                  |
|--------------------|---------------|------------------|---------------|------------------|---------------|------------------|---------------|------------------|
|                    | Bad eggs      | Percent of total | Bad eggs      | Percent of total | Bad eggs      | Percent of total | Bad eggs      | Percent of total |
| Found by candling: | <i>Number</i> |                  | <i>Number</i> |                  | <i>Number</i> |                  | <i>Number</i> |                  |
| Mixed rots.....    | 22            | 8.30             | 41            | 14.54            | 21            | 11.35            | 52            | 13.26            |
| White rots.....    | 7             | 2.64             | 12            | 4.25             | 9             | 4.87             | 27            | 6.89             |
| Black rots.....    | 1             | .38              | 10            | 3.55             | 3             | 1.62             | 10            | 2.55             |
| Moldy eggs.....    | 231           | 87.17            | 216           | 76.60            | 150           | 81.08            | 298           | 76.02            |
| Crusted yolks..... | 4             | 1.51             | 3             | 1.06             | 2             | 1.08             | 5             | 1.28             |
| Total.....         | 265           | 100.00           | 282           | 100.00           | 185           | 100.00           | 392           | 100.00           |
| Found by breaking: |               |                  |               |                  |               |                  |               |                  |
| Green whites.....  | 17            | 47.23            | 7             | 29.17            | 5             | 26.31            | 13            | 27.08            |
| Bad-odor eggs..... | 3             | 8.33             | 2             | 8.33             | 2             | 10.53            | 5             | 10.42            |
| Mixed rots.....    | 7             | 19.44            | 14            | 58.33            | 9             | 47.37            | 22            | 45.83            |
| White rots.....    |               |                  |               |                  |               |                  |               |                  |
| Moldy eggs.....    | 7             | 19.44            |               |                  | 2             | 10.53            | 5             | 10.42            |
| Crusted yolks..... | 2             | 5.56             | 1             | 4.17             | 1             | 5.26             | 3             | 6.25             |
| Total.....         | 36            | 100.00           | 24            | 100.00           | 19            | 100.00           | 48            | 100.00           |

<sup>1</sup> Data from cases of eggs withdrawn from storage from November to March.

TABLE 5.—*Variety of bad eggs developing during storage in eggs with cracked shells sorted from commercial refrigerators—Continued*

| Item               | April dirty eggs |                   | May dirty eggs |                   | June dirty eggs |                   | June Seconds  |                   | July Seconds  |                   |
|--------------------|------------------|-------------------|----------------|-------------------|-----------------|-------------------|---------------|-------------------|---------------|-------------------|
|                    | Bad eggs         | Per cent of total | Bad eggs       | Per cent of total | Bad eggs        | Per cent of total | Bad eggs      | Per cent of total | Bad eggs      | Per cent of total |
| Found by candling: | <i>Number</i>    |                   | <i>Number</i>  |                   | <i>Number</i>   |                   | <i>Number</i> |                   | <i>Number</i> |                   |
| Mixed rots.....    | 3                | 1.43              | 16             | 5.18              | 55              | 17.19             | 33            | 17.65             | 30            | 13.64             |
| White rots.....    | 9                | 4.31              | 22             | 7.12              | 24              | 7.50              | 16            | 8.55              | 24            | 10.91             |
| Black rots.....    | 7                | 3.35              | 34             | 11.00             | 7               | 2.19              | 4             | 2.14              | 4             | 1.82              |
| Moldy eggs.....    | 183              | 87.56             | 217            | 70.23             | 221             | 69.06             | 130           | 69.52             | 157           | 71.36             |
| Crusted yolks..... | 7                | 3.35              | 20             | 6.47              | 13              | 4.06              | 4             | 2.14              | 5             | 2.27              |
| Total.....         | 209              | 100.00            | 309            | 100.00            | 320             | 100.00            | 187           | 100.00            | 220           | 100.00            |
| Found by breaking: |                  |                   |                |                   |                 |                   |               |                   |               |                   |
| Green whites.....  |                  |                   |                |                   | 13              | 48.15             | 8             | 36.36             | 32            | 49.23             |
| Bad-odor eggs..... |                  |                   |                |                   | 5               | 18.52             | 4             | 18.18             | 18            | 27.69             |
| Mixed rots.....    |                  |                   |                |                   | 6               | 22.22             | 5             | 22.73             | 11            | 16.92             |
| White rots.....    |                  |                   |                |                   |                 |                   |               |                   | 1             | 1.54              |
| Moldy eggs.....    |                  |                   |                |                   | 2               | 7.41              | 2             | 9.09              |               |                   |
| Crusted yolks..... |                  |                   |                |                   | 1               | 3.70              | 3             | 13.64             | 3             | 4.62              |
| Total.....         |                  |                   |                |                   | 27              | 100.00            | 22            | 100.00            | 65            | 100.00            |

## RELATION OF QUALITY TO PRESERVATION

The initial quality of the eggs influences to a large extent their preservation by cold storage. Stale, weak, and hatch-spot eggs, which are only too plentiful in eggs marketed in the summer, lose heavily after a few months' holding in cold storage. In the experiment cited in table 6, the stale and heated eggs stored in July developed comparatively few bad eggs up to November, but from then until the end of March the loss was from 13.5 to 24 eggs per case detected by candling, with 9.5 to 19 additional detected by breaking. The number of bad eggs developing may be higher or lower than that found in this experiment, depending upon the degree of deterioration before the eggs entered storage. The most frequent types of bad eggs present in heated stock after storing are those with slightly stuck or broken-down yolks in various stages of spoiling. These eggs in the early stages are a form of mixed rot and are classed as such in table 4.

TABLE 6.—*Relation of quality of clean eggs to preservation*

| Month of withdrawal | Fresh eggs with clean, sound shells |               |               | Stale and heated eggs— |               |               |                     |               |               |
|---------------------|-------------------------------------|---------------|---------------|------------------------|---------------|---------------|---------------------|---------------|---------------|
|                     | Bad eggs per case found on—         |               |               | With clean shells      |               |               | With damaged shells |               |               |
|                     | Total observed                      | Candling      | Breaking      | Total observed         | Candling      | Breaking      | Total observed      | Candling      | Breaking      |
| April.....          | <i>Number</i>                       | <i>Number</i> | <i>Number</i> | <i>Number</i>          | <i>Number</i> | <i>Number</i> | <i>Number</i>       | <i>Number</i> | <i>Number</i> |
| May.....            | 1,026                               | 0             | 0.5           |                        |               |               |                     |               |               |
| June.....           |                                     |               |               |                        |               |               |                     |               |               |
| July.....           |                                     |               |               | 977                    | 0             | 0             | 90                  | 0             | 4             |
| August.....         |                                     |               |               | 949                    | 8             | 4             | 104                 | 58            | 3.5           |
| September.....      | 710                                 | 0             | 2.5           | 938                    | 6             | 9             | 106                 | 64            | 20.5          |
| October.....        | 704                                 | 1             | 1.5           | 949                    | 2.5           | 4.5           | 111                 | 83            | 32            |
| November.....       | 695                                 | 0.5           | 2             | 901                    | 13.5          | 9.5           | 109                 | 135.5         | 33            |
| December.....       | 709                                 | 0.5           | 1             | 954                    | 14.5          | 10.5          | 94                  | 175           | 11.5          |
| January.....        | 694                                 | 0             | 2.5           | 960                    | 14            | 14            | 100                 | 147.5         | 18            |
| February.....       | 715                                 | 1             | 2             | 926                    | 24            | 12.5          | 129                 | 232.5         | 19            |
| March.....          | 717                                 | 2.5           | 2.5           | 946                    | 23            | 19            | 96                  | 251           | 15            |

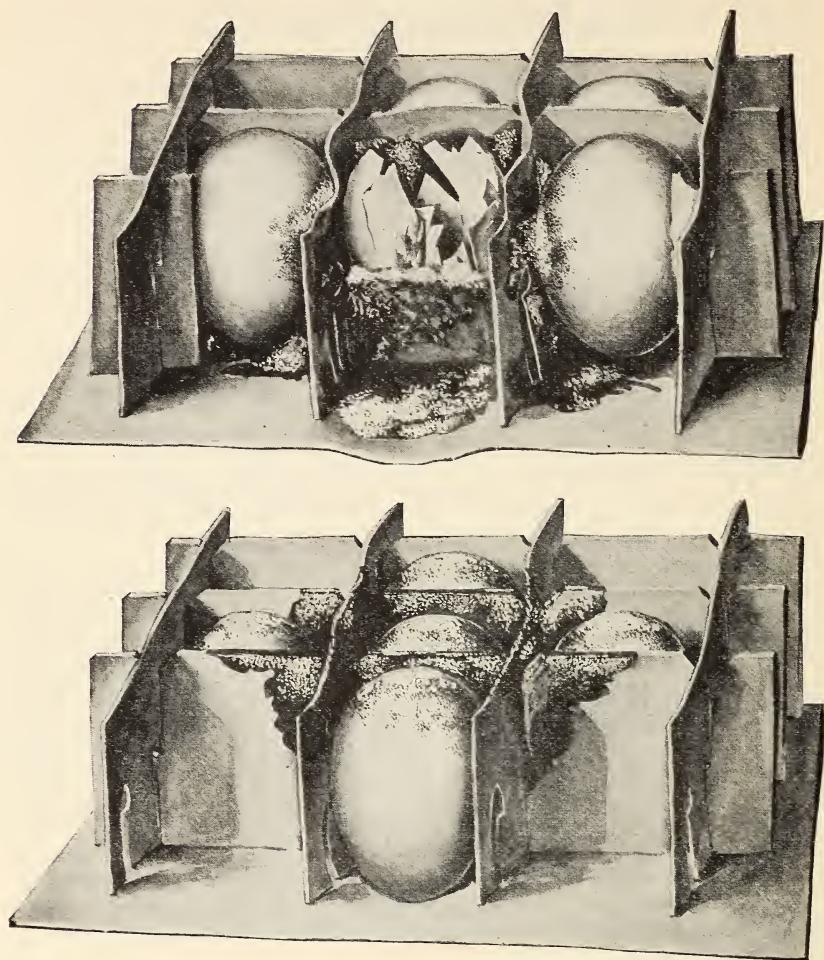


FIGURE 22.—Contamination of neighboring eggs by a molding leaker.

It does not follow, however, that because many of the eggs marketed in the summer months are shrunk and heated and do not keep well in storage, the eggs laid by the hen in the summer are not initially as good in quality as those laid in the spring. Among fresh hennery eggs laid in April and July and delivered to storage within approximately 48 hours of the time they were laid, there was a negligible number of bad eggs, even after a long period of storage (table 7). The only bad eggs present were some showing a slight breaking down of the yolk. No eggs with green whites or crusted yolks were found. Their absence was to be expected, because the natural condition of the shell had not been disturbed through soiling, washing, or contact with damp surroundings. The good results in this report show the improvement that may yet be attained in the commercial marketing of summer eggs.

TABLE 7.—*Relative keeping quality of hennerly eggs freshly laid in April and July*

| April hennerly eggs |                |               | July hennerly eggs |                |               |
|---------------------|----------------|---------------|--------------------|----------------|---------------|
| Months in storage   | Total observed | Bad eggs      | Months in storage  | Total observed | Bad eggs      |
|                     | <i>Number</i>  | <i>Number</i> |                    | <i>Number</i>  | <i>Number</i> |
| 7. 2                | 351            | 2             | 6. 5               | 275            | 1             |
| 11                  | 274            | 2             | 8. 5               | 267            | 2             |
|                     |                |               | 10. 8              | 241            | 0             |

After being held from 4 to 8 months, stale and heated cracked eggs stored in July included a total of 168.5 to 266 bad eggs per case (table 6). The greater loss in these eggs, in comparison with the loss in clean, cracked fresh eggs stored in the spring, may probably be explained by the development of larger numbers of molds and bacteria during the warm weather before the eggs are stored.

In short, these studies show that, for successful preservation, eggs to be stored for several months should have clean, sound shells, and should be fresh.

RELATION OF MONTH OF STORAGE TO NUMBER OF BAD EGGS DEVELOPING IN COLD-STORAGE FIRSTS AND SECONDS

"Market Firsts," commercially packed for storage in April, May, June, and July, were studied for three consecutive seasons. It was seen that the April and May commercially packed eggs included a low number of bad eggs more uniformly during the course of the storage period than did the June and July commercial stocks. This may be accounted for by the fact that most of the spring eggs on the market are fresh, are not shrunken, and have not been exposed to high temperatures before being stored. Some of the commercial summer Firsts contained no more bad eggs after storing than did the commercial spring Firsts. On the other hand, the commercial Seconds showed heavy losses, even after a comparatively short period of storage. Indeed, it would not pay to carry such low-quality eggs in storage after the fall months. In commercial practice few eggs are stored in summer, and practically all are withdrawn by November or December. In the summer when the general supply is poor in quality, dealers frequently draw from the spring stock in storage to fill orders that require eggs of good quality.

On withdrawal from storage between November and March, there were usually in commercial spring and high-grade summer Firsts from 12 to 18 bad eggs per case, detected by candling, and from 2 to 6 additional ones detected by breaking. On the other hand, summer Seconds and low-grade commercial summer Firsts, when withdrawn from storage between November and March, ordinarily contained from 18 to 42 bad eggs per case, determined by candling, and from 6 to 12 more found by breaking.

Undergrade eggs, consisting of those that are dirty, small, shrunken, or heated, usually are marketed directly in the shell or are used in the preparation of frozen and dried products. These grades of eggs are seldom stored, except for short intervals, as the industry realizes that they do not keep well in storage for long periods. It is frequently

convenient for the management of egg-breaking plants to buy large quantities of Seconds in the spring when eggs are plentiful and cheap, to store them for 1 or 2 months, and to open them when the supply of these eggs on the market is short and when otherwise the breaking room would be practically idle. This practice is warranted only for very short intervals. There may be no appreciable increase in bad eggs during a storage period of 4 or 5 months, but the general quality is much lower because of increased staleness and higher bacterial content. Because deterioration has already begun in them, summer Seconds should not be stored, even for short periods. They should be sold for immediate consumption or promptly broken and frozen. In short, for successful preservation in storage in the shell, eggs, like other perishable products, must initially be in prime condition.

#### CONDITION AND QUALITY OF COMMERCIALY PACKED EGGS AS STORED

Most warehousemen require an examination of the cases of eggs for mechanical damage before permitting them to be taken to the cold-storage rooms. The thoroughness of the examination depends upon the strictness of the management. The officials of some warehouses demand that representative portions of carload lots be inspected; others ask that each case be examined. In some cold-storage plants the examinations are made by the employees; in others, by the patrons. In the latter instance some firms exercise more care in inspection than the rulings of the warehouse require.

In the warehouse in which the eggs used in these investigations were stored, each patron examines the eggs he buys, and usually every case is opened. The top layers of each case are examined without being removed, or they are lifted from the case, and both the upper and lower sides of the layers are examined. When evidences of broken eggs are found in the top fillers, each layer is inspected, and all leaking eggs discovered are replaced by eggs with whole shells in dry fillers. If no breakage is found in the top layers the remaining layers are not disturbed.

The cases of eggs under observation were inspected by removing the top layers of each case and observing the upper and lower sides. These cases, then, represented the condition of commercial packages on entering storage. The eggs were next candled to determine quality and to ascertain the number of dirty, cracked, leaking, and bad eggs included with the good, clean eggs. Representative samples were also broken to discover the quality and to find the number of bad eggs not recognized by candling; and samples of the liquid edible product were prepared for chemical analysis.

The number of bad eggs found by candling among commercial spring Firsts, before storing, averaged from 0.5 to 2 eggs per case, as compared with 1.5 to 10 eggs per case in the summer-packed Firsts. As would be expected, the initial number of bad eggs in the summer Seconds was higher, averaging from 8.5 to 21.5 per case in the different lots. The bad eggs found by candling could not have been recognized by sorting, that is, by visual inspection and clicking of shells; therefore, their presence did not reflect upon the accuracy of the initial sorting, but upon the inadequacy of the system as compared with candling. The additional bad eggs found by breaking, consisting mostly of green whites, averaged from 0.5 to 4.5 eggs per case in

the spring and summer supply. The condition of these eggs, not recognizable by candling, would not be discovered in the routine of marketing until opened by the consumer.

The number of cracked eggs averaged from 14.5 to 29 per case in the storage-packed Firsts, and from 20 to 34 per case in the summer Seconds. The leakers averaged from none to three per case in the different lots studied, showing that the absence of damage in the top layers, as determined by commercial inspection, does not always indicate that there is none in the lower layers.

Some lots of storage-packed Firsts contained but few dirty eggs; others, on an average, 30 eggs per case. The presence of dirty eggs in commercial packages may be attributed directly to oversight or carelessness in the initial sorting of the eggs for storage.

#### TYPES OF BAD EGGS AFTER STORING

Studies were made to determine the relative number of bad eggs developing in storage from whole, cracked, and leaking eggs present in the commercial storage stocks. These observations were based on spring and summer eggs withdrawn at monthly intervals from November until March, inclusive. Three cases of each lot were examined monthly, but, for simplicity, the results for the entire period are averaged. It was observed that most of the bad eggs developing in storage-packed eggs were evident by November.

As might be expected, a large portion of the cracked eggs originally present in the commercial packages spoiled during storage. Out of the average of from 15 to 19.5 cracked eggs per case, present when the commercial spring Firsts entered storage, from 4 to 9 bad eggs per case developed, as detected by candling, and from 0.5 to 1.5 additional per case as found by breaking. The losses were still higher in the summer-packed Firsts.

Damaged eggs, particularly leaking eggs, in becoming moldy may contaminate neighboring eggs and cause them to spoil. When the contents of a broken egg leak out and soak into a strawboard filler, the filler usually becomes moldy, and causes any eggs that come in contact with it to mold. This contamination may extend to eggs in adjoining pockets or through flats to the eggs beneath. Figure 22 (p. 36) illustrates an aggravated case of the spoilage that may result from the presence of only one badly broken egg in the case. In the different lots of eggs studied, an average of from one to four eggs with sound shells per case was spoiled by leaking eggs.

Dirty eggs constituted but few of the bad eggs present in the commercially packed Firsts. As found by candling, the bad eggs with dirty shells averaged from none to 2.5 eggs per case in the different lots examined.

Clean eggs with sound shells constituted the majority of the eggs in the commercial cold-storage Firsts. In the spring stocks there were among these eggs, on an average, from two to seven bad eggs per case, found by candling, and, on an average, four others, found by breaking. In the summer stocks there were, on an average, 4.5 to 17 bad eggs per case, detected by candling, and 6.5 to 10.5 additional bad eggs, found by breaking. The inedible eggs in the clean summer Seconds with sound shells, as found by candling and opening, were practically the same in number as those in the poorer grade of summer Firsts.

A large proportion of the bad eggs in the spring Firsts with whole shells may be attributed to the presence of eggs which at some time previous to storage had had wet shells, because they were washed or for some other reason. If the dirt is left on the shells the eggs can be graded accordingly, but if the eggs are washed it is not always possible to differentiate between them and clean, unwashed eggs, with the result that washed eggs are frequently graded as Firsts. Washed eggs do not keep as well as dirty eggs. In eggs stored from summer production there is an additional loss due to the physical breaking down of the egg contents as a result of exposure to warm temperatures before they are stored.

These studies show that the following factors are responsible for the development of a large percentage of the bad eggs in commercial spring Firsts during storage: (1) Inaccuracies in the system of sorting eggs for storage; (2) inadequacy of that system in determining quality and in detecting bad eggs; and (3) to a lesser extent, damage during the railroad haul. The bad eggs developing during storage in the summer stocks are due to these factors, combined with a lower initial quality.

#### COMMERCIAL VERSUS CAREFULLY PREPARED PACKAGES

To determine the relation between care in initial grading and the number of bad eggs developing during storage, packages containing, so far as possible, only good eggs with clean whole shells were prepared from each lot of commercially packed eggs studied during the last two seasons of the investigation. To determine quality and to eliminate bad eggs, the eggs were selected by candling instead of simply by inspecting and clicking the shells.

Candling is a more accurate method for the detection of cracked eggs than is the clicking of shells, as ordinarily practiced. Enough carefully graded packages were prepared so that one case could be withdrawn monthly from storage with each three cases of corresponding commercially packed eggs. Following such a procedure, the carefully packed eggs, with one exception, contained an average of three cracked eggs per case after they had been carted from the commission house to the cold-storage warehouse and returned. Of this number, from one to two of the cracked eggs may be accounted for by handling error in putting up the eggs for storage, and the remainder by damage during cartage. The number of cracked eggs in the exception noted was unusually high, largely because of the use of a very poor grade of filler, so that more damage than usual was incurred during cartage.

In the summer commercial Firsts and Seconds, careful packing did much to reduce the number of bad eggs developing during storage, but it did not offset the losses due to the lower initial quality of the material.

It is believed that with a little attention given to the checking of the accuracy of the sorting of eggs for storage, the number of cracked and dirty eggs missed could be greatly lessened without materially reducing the amount of work accomplished. In addition, since the detection of cracked eggs depends upon hearing distinctly the sound emitted on tapping the eggs together, noises in the workroom should be eliminated as far as possible. Far greater efficiency, however, would be obtained by candling all eggs entering storage. Realizing

the importance of having a uniformly graded product. some of the more progressive western packers make a practice of candling all eggs stored, at the same time enforcing a checking system to see that the work is accurately done. This is a big step forward, for, by candling, the cracked eggs can be more accurately eliminated, and low-quality and bad eggs can be detected and discarded. Under such a system the graders become so skilled that the eggs they have examined are as good as the carefully packed stocks of this investigation.

Such eggs, being practically free from mold after several months in storage, are an advertisement for the firm that sells them, and in practice it has been found that their more uniform quality has obtained for them special outlets at higher prices. According to the present system of marketing, storage-packed eggs may pass through several hands before they are finally consumed, with the result that the original shipper seldom sees the condition of his goods when they are withdrawn from storage. For example, the packer in the producing section may sell to a commission man in the East, who in turn may sell to another dealer. Upon withdrawal from storage the eggs may go into another buyer's hands before they are finally graded for the retail market. In addition to stipulating that allowance be made for shrinkage before the candle and buying by weight, dealers in storage-packed eggs should demand that the cases be practically free from cracked eggs. This factor has received too little attention in the past, considering that frequently half of the bad eggs developing during storage come from the cracked eggs.

In the end the original packer bears the burden of expense of the stale, dirty, cracked, leaking, and bad eggs included in the storage grade, for, in order to be safe, buyers must pay a lower price for the whole package than they would if sure of receiving cases that contain only large, clean, fresh eggs with whole shells. If there is no direct market for the cracked, dirty, shrunken, and leaking eggs in the shell, their initial quality can be conserved by breaking and freezing in cans. Ordinarily there is a good market for frozen-egg products.

#### SHRINKAGE OF EGGS AND ABSORPTION OF MOISTURE BY CASE AND FILLERS

Changes in weight of eggs, case, and fillers were studied in three different storage rooms. All the weighings were made in the room where the eggs were held, because it was found that the cases and fillers frequently gained in weight if removed to a higher temperature. A sensitive scale was used. First the gross weight was found; then the eggs were transferred to a second case, and the fillers and the case were weighed. The net weight of the eggs was determined by difference. After being weighed the eggs were returned to the original cases and fillers, so that the periodical weighings during the storage period were made of the same cases, fillers, and eggs.

There was an almost regular decrease in the net weight of the eggs during the course of the storage period, amounting to an average of 4.48 ounces per case per month for eggs stored in room 1; and 3.46 ounces per month for eggs stored in rooms 2 and 3. In room 1 the decrease in the gross weight of a case of eggs weighing initially 56.84 pounds gross and 45.8 pounds net was 25.29 and 38.2 ounces, respectively, during a storage period of 9.2 months. In room 2 a case of eggs weighing 57.33 pounds gross and 45.01 pounds net at the begin-

ning of the season had lost 12.73 ounces gross and 26.14 ounces net after 9 months in storage. These typical results show that attempts to determine shrinkage of eggs by finding changes in weight of the total package alone, a procedure frequently followed commercially, give misleading figures.

The amount of moisture absorbed by the fillers and case varied in different rooms and for different cases in the same room during the storage period. Probably most of the moisture absorbed is from the water evaporating from the eggs. Cases exposed to drafts from the outside, as through the opening of doors, would condense moisture from the incoming air, but under ordinary conditions the moisture coming from this source would be small in quantity as compared with that derived from the eggs. Most of the moisture was taken up by the case and fillers during the first 4 or 5 months, and from this time on the weights usually showed a slight gain or remained practically stationary. In room 1, fillers having an initial weight of 3.61 and 3.68 pounds gained 3.99 and 4.13 ounces, respectively, after 9.2 months in storage; and in room 2, of two sets of fillers each weighing 3.7 pounds at the beginning, one gained 6.17 and the other 6.81 ounces in 9 months. In room 1 cases weighing 7.74 and 8.16 pounds at the outset absorbed 4.73 and 3.10 ounces, respectively, of moisture in 9.2 months; and in room 2, of two cases each weighing 7.98 pounds, one gained 6.7 ounces and the other 7.8 ounces of moisture during practically the same period of time.

The temperature of the three rooms in which these observations were made was practically uniform throughout the storage period. For example, in room 3 the fluctuations in temperature were rarely more than 3° F., except during the severe winter, when the thermometer dropped to 28° and occasionally to 26° for a few hours. During most of the season the average temperature was 31°.

#### PHYSICAL AND CHEMICAL CHANGES IN EGGS DURING STORAGE

During the commercial holding of eggs in cold storage the air space increases in size because of the evaporation of moisture; the white becomes thinner and eventually loses its opalescence. After 6 or 7 months the white usually develops a yellow tinge, which deepens with the length of the storage period. The clouded appearance of the white is especially noticeable when eggs are separated in large quantities, as is done in a commercial egg-breaking room. The slightly yellow color does not destroy the beating quality of the white nor the porcelain-white color of the resulting froth. The yolk membrane weakens slowly, but if the eggs are fresh when stored, most of them can be separated, even after being stored for 11 months. The separation is usually not so easy as in the earlier part of the storage period. If the physical condition of the egg is weakened through its being stale, or heated, or both, separation is difficult after it has been held in storage for only a few months.

Accompanying the evaporation of moisture from the egg, Greenlee<sup>3</sup> found that there was a transfer of moisture from the white to the yolk by osmosis. For example, samples of whites and yolks that contained 87.42 and 49.15 percent of moisture, respectively, after being held

<sup>3</sup> GREENLEE, A. D. DETERIORATION OF EGGS AS SHOWN BY CHANGES IN THE MOISTURE CONTENT. U. S. Bur. Chem. Cir. 83, 7 p., illus. 1911.

in storage for 41 days, contained 85.35 and 50.6 percent, respectively, at the end of 266 days in storage.

The amount of ammoniacal nitrogen <sup>4</sup> in samples of April- and May-storage eggs graded as edible on being candled and broken was found to be initially from 0.0012 to 0.0021 percent on the wet basis; and was found to increase gradually during storage to about 0.003 percent in November or December (that is, the seventh or eighth month in storage), and to remain nearly stationary or even to rise slightly until the end of March, the close of the storage period. Summer eggs that enter storage with the same degree of freshness as the spring eggs showed practically the same increase during the same period of holding.

In samples having a high initial percentage of ammonia, the slowing down in the production of ammonia seemed to occur sooner than in the case of the better quality eggs. This may, perhaps, be explained by the chemical change that took place before the eggs were stored. The amount of ammoniacal nitrogen in the summer Firsts and Seconds was less consistent during the different months of storage than in the spring eggs. This may be explained by variations in quality between different cases in the same lot, a condition of frequent occurrence in summer shipments. There was little difference in ammoniacal nitrogen in samples prepared from cracked eggs and those from eggs with whole shells sorted from the same lot. The evidence seems to show that even though the loss in unmarketable eggs varies with different classes, such as clean, dirty, and cracked eggs, if the eggs initially have the same interior quality, those that do keep show practically the same degree of preservation, judged by physical appearance and the amount of ammoniacal nitrogen present.

Pennington, Hendrickson, and collaborators <sup>5</sup> found that during a storage period of 6 months there was no change in the dextrose in eggs provided they were not infected with bacteria. In unpublished studies by these investigators, it was found that even up to 10 months' storage the dextrose content remained constant.

Sharp, <sup>6</sup> who worked with Powell for a time, reports results of their joint work and also of his own later as follows:

It has been found \* \* \* by Sharp and Powell that as soon as the egg is laid the pH of the white begins to increase, due to the loss of carbon dioxide. Actually, this change in pH may be from about 7.6, the pH of the white of a fresh egg, to 9.7. This means an increase in alkalinity of approximately one hundred times. The yolk of the fresh egg (1:1 dilution) has a pH of about 6. It also increases in pH during storage until a value of about 6.8 may be reached after long periods. The yolk, however, changes in pN more slowly than does the white. The increase in pH of the yolk is due to a loss of carbon dioxide from the yolk to the white which in turn loses it to the surrounding air. \* \* \*

The adjustment of the pH of the egg contents by means of carbon dioxide is of great practical importance since a relatively small amount of carbon dioxide in an air atmosphere will markedly retard deteriorative changes. The carbon dioxide produces markedly beneficial results at any temperature to which the eggs are subjected, proportionately greater amounts of carbon dioxide being required at the higher temperatures, and proportionately greater benefits being obtained. Carbon dioxide can be introduced into the air atmosphere of cold-storage rooms in concentrations which greatly retard the destructive changes in the eggs, and yet

<sup>4</sup> The determinations of ammoniacal nitrogen in these samples were made by G. C. Swan, according to the methods described in the following publication: HENDRICKSON, N., and SWAN, G. C. DETERMINATION OF LOOSELY BOUND NITROGEN AS AMMONIA IN EGGS. *Jour. Indus. and Engin. Chem.* 10: 614-617. 1918.

<sup>5</sup> PENNINGTON, M. E., HENDRICKSON, N., CONNOLLY, E. L., and HENDRIX, B. M. DEXTROSE CONTENT OF THE EGG OF THE COMMON FOWL. (Abstract) *Jour. Biol. Chem.* 20: xxi. 1915.

<sup>6</sup> P. F. SHARP. THE PH OF THE WHITE AS AN IMPORTANT FACTOR INFLUENCING THE KEEPING QUALITY OF HEN'S EGGS. *Science* 69: 278-280. 1929.

the concentration will not be so high as to prevent workmen from entering the storage rooms. \* \* \*

It has been estimated that if enough carbon dioxide were added to a storage room once each week for 6 months to give a concentration in the atmosphere of 1 percent, the cost of the carbon dioxide would be less than 1 cent per case of eggs, or less than 0.03 cent per dozen. It would, however, be necessary to replenish the carbon dioxide more often, unless the walls of the storage room were so treated as to make them more impermeable to carbon dioxide.

The only method that approaches the one here described in cheapness and practicability is the oil-dipping method, in which eggs are dipped for a short time in a suitable oil which very nearly seals the pores, and the eggs are then stored. The oil dipping largely prevents the loss of moisture and very materially slows down the rate of the loss of carbon dioxide. If the eggs are oil-dipped as soon as they are laid, the preserving effect of a low pH is obtained, but the thick white becomes turbid during storage. If a considerable part of the carbon dioxide which was originally present in the eggs is allowed to escape before the eggs are dipped, then the turbidity of the white may be avoided, but the full preserving effect of the low pH is not obtained. Some carbon dioxide will diffuse from the yolk to the white after the eggs are dipped so that the pH of the white is somewhat lower than if the eggs were not oil-dipped. If it is desired to oil dip eggs in which the pH has risen and obtain the full preserving effect of the low pH, all that is necessary is to place the eggs in an atmosphere containing sufficient carbon dioxide to lower the pH to the point desired, and then dip the eggs. If eggs which are not oil-dipped are maintained in an atmosphere containing sufficient carbon dioxide to hold the pH down to near that of fresh egg white, a turbidity also appears in the white, but this turbidity disappears when the eggs are removed from the carbon dioxide atmosphere and some of the carbon dioxide is allowed to escape.

#### ABSORPTION OF FOREIGN FLAVORS DURING STORAGE

It has been found that under commercial conditions a characteristic unpleasant flavor, commonly termed the "cold-storage taste," develops in eggs that have been held in cold storage for several months. It is especially noticeable when the eggs are soft boiled or poached. The flavor is not so marked in the white as in the yolk, which contains a large percentage of fat. It is known that fats have an affinity for odors and flavors. The facts indicate that the cold-storage taste is due to the absorption of surrounding odors. When closed, the storage room itself has some odor, as have also the cases and excelsior, but the strawboard fillers and flats possess an odor more nearly resembling that found in storage eggs. The fillers and flats become slightly damp in storage, because of the absorption of moisture evaporating from the eggs and the air of the room, and they acquire a stronger odor than they have when dry.

#### INVESTIGATIONS IN COMMERCIAL PRESERVATION OF POULTRY BY COLD STORAGE

Many investigations have been made during the last two decades by the Bureau of Chemistry (now the Bureau of Chemistry and Soils) to determine the chemical changes that occur in poultry during the freezing period.

Various lots of poultry have been stored, both dry-picked and scalded, and observations made at frequent intervals during the storage period. A brief summary of the results obtained is here given.

Poultry with the entrails removed showed greater deterioration in quality than did undrawn poultry. The flesh was dry and unpalatable and a strong storage taste quickly developed.

Dry-picked poultry was found to keep much better than scalded poultry.

Poultry with cut or broken skin was more readily infected with bacteria than that which was sound and free from bruises and abrasions. This condition held true even with poultry that had been carefully chilled and properly prepared and dressed.

Cold-storage flavor developed and could readily be detected after the poultry had been in storage 4 months.

Improper bleeding during dressing caused the meat to turn dark soon after it was frozen.

Odors and darkening of the flesh gradually increased with the length of the storage period, even when the product was sound and had been properly stored.

The bacterial content of poultry that had not been properly starved before slaughter was very heavy. The intestines of the birds prevent bacterial invasion of the meat if they are not expanded. Heavy feeding before slaughter dilates the walls of the digestive tract and lowers their bacterial resistance.

The chemical analysis of well-prepared poultry showed little material change during the period of storage. Fatty acid in the abdominal fat practically doubled after the poultry had been held 4½ months in storage, but at that time the average fatty acid content was only 0.42 percent.

#### MARGINS DERIVED FROM STORAGE

Among persons not familiar with the egg and poultry industry, there seems to be an impression that since the prices of eggs are usually higher in wintertime than in the spring or summer anyone who stores eggs during the latter season is sure of financial profits. There are many things not apparent to the layman, however, to be taken into consideration. It is true that prices for fresh eggs average higher in the winter than in the spring, but it is not always true that prices for storage eggs follow this trend. The cost of storing eggs, although apparently small per month, is a considerable item of expense in the course of a season. Added to this is the interest on the money invested, the insurance, and the deterioration in quality. This last item is probably the most important, for many eggs that go into storage are of a higher grade than when they come out. This means that eggs bought as storage-packed Extra Firsts must often be sold as refrigerator Firsts, and the difference in price between the two grades often represents the profit or loss that the holder will make on his storage holdings. No matter how carefully eggs are prepared there is sure to be some storage loss from spoiled, broken, or watery eggs.

The cost of holding eggs in storage varies to some extent according to conditions and type of warehouse. The following tabulation gives the representative cost of holding 25-cent eggs for a period of 8 months:

|                                          | <i>Cents</i> |
|------------------------------------------|--------------|
| Warehouse charges per dozen.....         | 2. 1         |
| Interest on investment at 6 percent..... | 1. 0         |
| Insurance at 15 cents per \$100.....     | . 02         |
| Estimated depreciation and loss.....     | 1. 0         |
| Total cost at time of delivery.....      | 4. 12        |

Not counting the 1-cent depreciation, as figured in this tabulation, the carrying charges alone amounted to 3.12 cents per dozen, or practically 12½ percent of the original cost of the eggs.

The storage charges on poultry, figured in terms of percentage, are practically the same as those on eggs, but the total carrying charges are somewhat higher as more money is involved in the investment.

The great difficulty with storage eggs or poultry as a speculation is in being able to sell the products at the high market price. The successful operator is the one best able to judge the market trends and dispose of his holdings at the peak prices. Market reports are carefully watched, and the reports on cold-storage holdings issued by the Department of Agriculture are studied carefully. The rate of consumption and weather conditions must be taken into consideration in judging market trends, and general financial conditions and prices of other food commodities are important factors.

Cautious operators always endeavor to dispose of their holdings of eggs by the first of January, as the new egg crop soon to follow will tend to reduce the demand for storage eggs. Occasionally, however, a shortage of eggs will result in January or even as late as February, and the highest prices for the storage season will be reached in those months. The reverse is often the case, and the greatest financial losses are sometimes caused by holding the products too late in the season.

Table 8 shows the average selling price per dozen by months of refrigerator Firsts on the New York market for the years 1932 to January 1936, inclusive. Over 90 percent of the storage eggs are sold during these months.

TABLE 8.—*Refrigerator Firsts, average selling price per dozen at wholesale in New York, specified months, 1932-33 to 1936-37*

| Month          | 1932-33      | 1933-34      | 1934-35      | 1935-36      | 1936-37      |
|----------------|--------------|--------------|--------------|--------------|--------------|
|                | <i>Cents</i> | <i>Cents</i> | <i>Cents</i> | <i>Cents</i> | <i>Cents</i> |
| September..... | 18.85        | 16.25        | 21.31        | 26.60        | 25.00        |
| October.....   | 22.23        | 16.84        | 21.61        | 25.72        | 26.00        |
| November.....  | 24.63        | 15.98        | 22.82        | 23.54        | 28.15        |
| December.....  | 27.60        | 15.34        | 22.55        | 21.43        | 28.60        |
| January.....   | 24.05        | 20.60        | 26.27        | 20.80        | 22.09        |

If the highest storage-egg market occurred the same month each year, it would be a simple matter for the holder to dispose of his stock to the best advantage. But table 8 shows that in 1932 the highest prices were reached in December and that the highest prices for the 1933 crop were not reached until January 1934. The highest price for the 1934 crop was reached in January 1935; the highest price for the 1935 crop in September of that year; and the highest price for the 1936 crop in December.

The selling price of frozen poultry shows less variation by months than the selling price of eggs, but there is fluctuation in prices which the holder must watch carefully.

In 1931 the price of frozen broilers on the New York market dropped from 36.8 cents per pound in January to 28.1 cents per pound in July. The price of fryers dropped from 24 to 18.3 cents during the same months in 1932, and fowl from 23 to 18.8 cents. These are extreme cases, for prices as a general rule tend to be much more uniform. Table 9 shows the price of frozen broilers, fryers, roasters, and fowl on the New York market for the 7 principal selling months, beginning with 1932 and ended with 1936.

TABLE 9.—Average selling price per pound of principal classes of poultry, New York market, specified months, 1932-36

| Month         | 1932                      |                         |                             |                       | 1933                      |                         |                             |                       |
|---------------|---------------------------|-------------------------|-----------------------------|-----------------------|---------------------------|-------------------------|-----------------------------|-----------------------|
|               | Broilers<br>(2-<br>pound) | Fryers<br>(3-<br>pound) | Roasters<br>(4-5-<br>pound) | Fowl<br>(5-<br>pound) | Broilers<br>(2-<br>pound) | Fryers<br>(3-<br>pound) | Roasters<br>(4-5-<br>pound) | Fowl<br>(5-<br>pound) |
|               | <i>Cents</i>              | <i>Cents</i>            | <i>Cents</i>                | <i>Cents</i>          | <i>Cents</i>              | <i>Cents</i>            | <i>Cents</i>                | <i>Cents</i>          |
| January.....  | 30.0                      | 24.0                    | 26.3                        | 23.0                  | 23.0                      | 18.0                    | 19.0                        | 17.5                  |
| February..... | 26.8                      | 24.0                    | 26.5                        | 21.9                  | 22.0                      | 18.0                    | 19.0                        | 17.0                  |
| March.....    | 24.9                      | 24.0                    | 26.5                        | 22.1                  | 21.0                      | 17.1                    | 19.2                        | 15.9                  |
| April.....    | 22.0                      | 24.0                    | 26.5                        | 20.0                  | 22.0                      | 18.0                    | 20.3                        | 17.0                  |
| May.....      | 20.4                      | 22.8                    | 26.5                        | 19.9                  | 23.8                      | 18.9                    | 22.7                        | 17.3                  |
| June.....     | 20.3                      | 20.9                    | 26.3                        | 18.8                  | 20.6                      | 18.5                    | 23.3                        | 15.8                  |
| July.....     | 21.0                      | 18.3                    | 24.9                        | 18.8                  | 19.0                      | 17.5                    | 23.0                        | 15.8                  |

| Month         | 1934                      |                         |                             |                       | 1935                      |                         |                             |                       |
|---------------|---------------------------|-------------------------|-----------------------------|-----------------------|---------------------------|-------------------------|-----------------------------|-----------------------|
|               | Broilers<br>(2-<br>pound) | Fryers<br>(3-<br>pound) | Roasters<br>(4-5-<br>pound) | Fowl<br>(5-<br>pound) | Broilers<br>(2-<br>pound) | Fryers<br>(3-<br>pound) | Roasters<br>(4-5-<br>pound) | Fowl<br>(5-<br>pound) |
|               | <i>Cents</i>              | <i>Cents</i>            | <i>Cents</i>                | <i>Cents</i>          | <i>Cents</i>              | <i>Cents</i>            | <i>Cents</i>                | <i>Cents</i>          |
| January.....  | 21.0                      | 17.0                    | 19.8                        | 16.8                  | 23.0                      | 21.2                    | 25.1                        | 20.9                  |
| February..... | 21.0                      | 17.0                    | 20.0                        | 16.0                  | 23.0                      | 22.4                    | 26.2                        | 22.5                  |
| March.....    | 21.0                      | 17.4                    | 20.9                        | 16.4                  | 23.0                      | 22.9                    | 26.7                        | 23.1                  |
| April.....    | 21.4                      | 18.8                    | 21.8                        | 18.2                  | 23.2                      | 23.4                    | 27.5                        | 24.9                  |
| May.....      | 23.8                      | 21.0                    | 23.3                        | -----                 | 23.8                      | 23.9                    | 28.0                        | -----                 |
| June.....     | -----                     | 24.5                    | 24.5                        | -----                 | 22.1                      | 23.6                    | 28.4                        | -----                 |
| July.....     | -----                     | -----                   | 25.1                        | -----                 | 19.1                      | 22.0                    | 27.8                        | -----                 |

| Month         | 1936                      |                         |                             |                       |
|---------------|---------------------------|-------------------------|-----------------------------|-----------------------|
|               | Broilers<br>(2-<br>pound) | Fryers<br>(3-<br>pound) | Roasters<br>(4-5-<br>pound) | Fowl<br>(5-<br>pound) |
|               | <i>Cents</i>              | <i>Cents</i>            | <i>Cents</i>                | <i>Cents</i>          |
| January.....  | 31.5                      | 26.0                    | 28.0                        | 26.5                  |
| February..... | 30.0                      | 26.0                    | 28.0                        | 25.7                  |
| March.....    | 29.6                      | 25.6                    | 28.4                        | 25.5                  |
| April.....    | 30.3                      | 25.4                    | 28.5                        | 26.6                  |
| May.....      | -----                     | 25.5                    | 29.4                        | -----                 |
| June.....     | -----                     | 25.5                    | 29.6                        | -----                 |
| July.....     | -----                     | 25.6                    | 29.7                        | 25.1                  |

It can be readily seen that the speculation in storing either eggs or poultry is precarious and, for success, requires experience and knowledge of the business. The great majority of the storage eggs and poultry is stored by marketmen, whose purpose is to assure themselves of an adequate, uniform pack with which to conduct their business, rather than with the speculative profits in view. To this type of merchant, whose natural trade outlet will consume all his holdings, there is every advantage in storing his product and thus assuring his future supply. To the speculator, who has no established outlet whereby he may dispose of his holdings regardless of the market change, the transaction is a hazardous one, and it should be approached with caution.

#### GROWING APPRECIATION OF COLD-STORAGE PRODUCTS

The poultry industry owes much to cold storage. Eggs in the spring of the year would be worthless if they could not be preserved until the fall and winter months. The same condition is true of poultry meat, though to a somewhat less extent. Chickens can now be purchased throughout the entire year at reasonable cost, whereas without cold storage some classes would be available in adequate quantities only during the summer and fall months.

The quality of both storage poultry and storage eggs at certain seasons of the year is superior to the fresh product usually found on the market. The ordinary receipts of fresh eggs coming into the market

during the summer months, because of the heat to which they have been subjected, are usually inferior to eggs laid and stored during the cool months earlier in the season.

Young fresh-dressed chickens, purchased during the winter and early spring months, are likewise of inferior quality, excepting those raised on specialized poultry farms. The ordinary farm-raised late-fall or winter chicken is usually coarse-meated and staggy, and the flesh is poorly flavored and tough.

A bird of the same size that has been killed and stored in the early fall is much better flavored, is soft-meated, and is tender when properly cooked. The most experienced person would have some difficulty in detecting any storage flavor in poultry that has been properly prepared and frozen, even after 2 or 3 months of storage.

The consuming public should feel indebted, therefore, to cold storage for making supplies of these two important food products available in sufficient quantity and at moderate price. But this does not always happen, partly because of the lack of knowledge on the consumer's part as to the desirability of the storage product, and partly because of the fact that during the experimental stage of the industry, the products stored were not preserved so well as they are at the present time. Some of the produce dealers have unfortunately done much to injure the storage industry by placing inferior quality, or stock that has been thawed, back in the storage for refreezing. Decomposition takes place rapidly in stocks of this kind and even continues slowly after the product is frozen. In most cases dealers would benefit the industry if they would dispose of inferior stock even at a financial loss, rather than replace it in storage to unload on the consuming public at a later date.

The retail merchant should recognize the value of cold storage in the marketing of eggs and poultry when applied to his own business and should endeavor to acquaint his customers with its value. Instead, many of them in times past have engendered and fostered prejudice against cold-storage products. Instead of advertising the value and wholesomeness of the cold-storage egg or the cold-storage fowl they have advertised that no storage product could be bought in their establishments. Too often they excuse their own high prices as compared with competitors' lower ones on the ground that the latter are handling a cold-storage product, thus giving the impression to the consumer that it must be of inferior quality and consequently of less value.

#### COLD-STORAGE REPORTS AND HOW THEY ARE MADE

Each month the Bureau issues a mimeographed report showing the amount of holdings in cold storage of poultry, of shell and frozen eggs, and of dairy products (fig. 23). The information contained in these reports is of great value to the poultry industry. With this information the producer is enabled to plan his future production, the consumer is informed of the supply available, and the packer can more readily forecast his future requirements. The most important classes of poultry (fowl, roasters, fryers, broilers, ducks, and turkeys) are reported separately, and geese, capons, and less important classes, as well as some unclassified poultry, are reported together under miscellaneous poultry.

The first of these reports of storage holdings of shell eggs was made in 1916 and of frozen eggs and poultry in 1917. They have been issued regularly since that time.

Compilation of these reports depends upon voluntary information received by the Bureau from nearly 1,200 storage warehouses, about half of which report holdings of poultry products. It is estimated

UNITED STATES DEPARTMENT OF AGRICULTURE  
Bureau of Agricultural Economics

MONTHLY COLD-STORAGE REPORT - TOTAL U. S. STOCKS  
JANUARY 1, 1937.

| COMMODITY                 | DAIRY PRODUCTS AND EGGS (000 Omitted) |              |           |              |           |         |
|---------------------------|---------------------------------------|--------------|-----------|--------------|-----------|---------|
|                           | Dec. 1, :                             | 5-Yr. Avg. : | Dec. 1, : | 5-Yr. Avg. : | Jan. 1, : | Jan. 1  |
|                           | 1931-1936:                            | 1936         | 1936      | 1931-1936:   | 1936      | 1937    |
|                           | 1931-1936:                            | 1936         | 1936      | 1931-1936:   | 1936      | 1937    |
| 40% Cream, 40-qt. cans    | 144:                                  | 134:         | 176:      | 117:         | 96:       | 144     |
| 20% Cream, 40-qt. cans    | 2:                                    | 6:           | 12:       | 2:           | 5:        | 10      |
| Butter, Creamery (Lbs):   | 74,119:                               | 71,948:      | 88,866:   | 49,445:      | 40,117:   | 61,228  |
| Butter, Packing Stock     | " :                                   | 142:         | 888:      | " :          | 74:       | 602     |
| Cheese, American          | " :                                   | 80,638:      | 92,912:   | 98,975:      | 74,548:   | 86,537: |
| Cheese, Swiss             | " :                                   | 6,637:       | 5,217:    | 4,455:       | 6,621:    | 5,379:  |
| Cheese, Brick & Munster   | " :                                   | 796:         | 525:      | 1,251:       | 853:      | 632:    |
| Cheese, Limburger         | " :                                   | 1,006:       | 717:      | 1,207:       | 1,039:    | 694:    |
| Cheese, All Other         | " :                                   | 5,241:       | 5,290:    | 8,818:       | 5,093:    | 6,330:  |
| Eggs, Shell, (cases)      | 2,481:                                | 2,738:       | 1,755:    | 795:         | 984:      | 650     |
| Eggs, Frozen (Lbs):       | 75,603:                               | 79,035:      | 66,309:   | 66,076:      | 69,546:   | 51,768  |
| Frozen, (Case Equivalent) | 2,160:                                | 2,258:       | 1,895:    | 1,888:       | 1,987:    | 1,479   |
| Total, (Case Equivalent)  | :                                     | :            | :         | :            | :         | :       |
| Both shell & frozen       | 4,641:                                | 4,996:       | 3,650:    | 2,683:       | 2,951:    | 2,129   |
| Whites %                  | :                                     | :            | :         | :            | :         | 29      |
| Yolks %                   | :                                     | :            | :         | :            | :         | 26      |
| Mixed %                   | :                                     | :            | :         | :            | :         | 45      |
| Frozen, % of total        | :                                     | :            | :         | :            | :         | 74      |

| FROZEN POULTRY (000 Omitted) |         |            |         |                    |          |
|------------------------------|---------|------------|---------|--------------------|----------|
| Broilers (Lbs):              | 14,612: | 11,178:    | 27,089: | 14,787:            | 11,558:  |
| Fryers                       | " :     | 10,706:    | 11,394: | 17,581:            | 13,062:  |
| Roosters                     | " :     | 24,556:    | 23,451: | 28,099:            | 34,962:  |
| Fowls                        | " :     | 13,186:    | 12,525: | 27,133:            | 17,251:  |
| Turkeys                      | " :     | 8,461:     | 9,114:  | 18,460:            | 15,222:  |
| Ducks                        | " :     | :          | 4,065:  | 5,247:             | :        |
| Miscellaneous                | " :     | 1/ 20,327: | 14,371: | 25,782: 1/ 22,962: | 14,741:  |
| Total                        | :       | 91,848:    | 86,098: | 149,391:           | 118,246: |

Note: These figures include stocks in public and private cold storage warehouses also meat packing plants.

1/ The 5-year average on miscellaneous poultry is not comparable in that ducks were included in miscellaneous poultry previous to July 1, 1932.

\* Figures shown subject to revision. Revised figures will appear in next month's report.

Figure 23.--A monthly cold-storage report compiled from figures supplied by individual cold storage warehouses.

that the reporting warehousemen store over 99 percent of the total for the country. Before it is given out, the report is checked and rechecked for possible errors by a board of statisticians and specialists. Incorrect reports from warehouses and clerical errors occasionally occur, but the reports do not usually vary more than 0.5 percent from the actual holdings.

This monthly report was formerly issued about the 17th of the following month. As more systematic methods were employed and as warehousemen reported more promptly, reports were released more promptly. The holdings are now published on the 12th of each month, unless that day falls on Saturday, on Sunday, or on a holiday, in which case the report is released on the 11th or 13th. The release is eagerly awaited by the produce trade, and some price fluctuations occur occasionally if holdings are much larger or smaller than expected. To prevent undue speculation in the market, and to give dealers a definite trend of the movement into storage, a weekly and a daily report are now issued. The weekly report gives the holdings in 26 of the most important storage centers, and the daily report gives the holdings in 10 most important storage centers. As the latter covers about 50 percent of the total, and as the 26 cities contain about 70 percent of the total, a close estimate can be made of the forthcoming monthly report, and the total figures are largely anticipated before the report is issued.

By observing the weekly cold-storage report of holdings in 26 cities, a fairly accurate estimate can be made of the entire holdings in the United States (fig. 24). But in spite of this fact great caution is exercised in releasing the report. Private and commercial telegrams, giving the holdings, are timed and sent to the more distant branches of the Bureau, so that the trade in all parts of the country can have the information at practically the same hour.

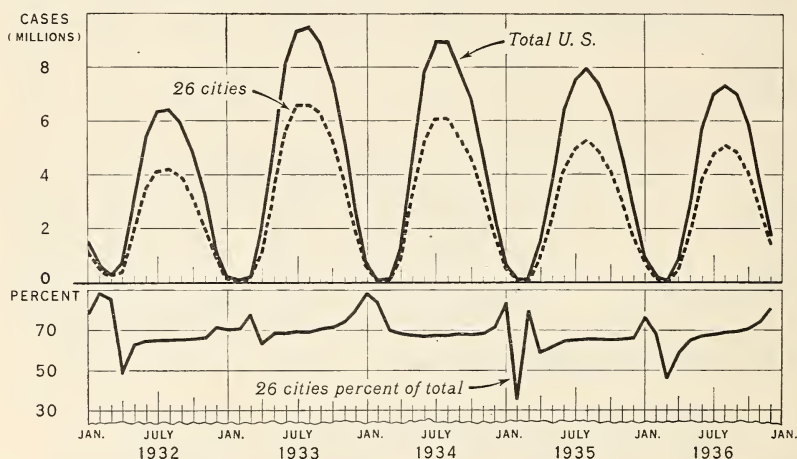


FIGURE 24.—COLD-STORAGE HOLDINGS OF EGGS IN 26 CITIES AND IN THE ENTIRE UNITED STATES, 1932-36.

Storage stocks at 26 cities are enumerated weekly and are equivalent to about 70 percent of the total.

Table 10, showing the dates of release during 1936, will enable one to judge with accuracy the release dates on succeeding years. When the 12th falls on Sunday, the report is often carried over to the 13th, and when it falls on Saturday, the report sometimes is released on the 11th. As October 12 is a legal holiday in some States, the report is issued earlier or later in that month.

TABLE 10.—*Release dates of cold-storage reports, 1936*

| Month         | Date of release | Day of week | Month          | Date of release | Day of week |
|---------------|-----------------|-------------|----------------|-----------------|-------------|
| January.....  | 13              | Monday.     | July.....      | 13              | Monday.     |
| February..... | 13              | Thursday.   | August.....    | 12              | Wednesday.  |
| March.....    | 12              | Do.         | September..... | 14              | Monday.     |
| April.....    | 13              | Monday.     | October.....   | 13              | Tuesday.    |
| May.....      | 12              | Tuesday.    | November.....  | 12              | Thursday.   |
| June.....     | 12              | Friday.     | December.....  | 11              | Friday.     |

## FUTURE OF THE INDUSTRY

The trend of recent years toward early hatching, and the scientific management of poultry flocks which now makes more winter egg production possible, have lengthened the season for fresh supplies. On the surface this would seem to indicate less need of holding the products in storage, but since the natural inclination of reproduction of the hen is in the spring of the year, and since chicks can be reared more economically in warm weather than in cold, the storage houses will probably not be seriously affected by the out-of-season production. This will be particularly true because the increasing population, especially in the consuming centers, will naturally require a greater supply of foodstuffs.

The gradual increase in the knowledge of the housewife regarding the use and wholesomeness of storage eggs and storage poultry is already doing much to increase the consumption of these products, and there is reason to believe that their popularity and consumption will increase.

Dealers can do much toward increasing consumption by storing and offering for sale only the better grades of both eggs and poultry so that when once purchased the product will give a satisfaction that will merit its continued use. Storage holdings of poultry products should be disposed of from season to season so that the quality of the products may be maintained. Economic factors are such that the carrying over into the second season is invariably attended by financial loss. Improvement in methods of grading and packing and in the care of poultry and eggs, both before and after storing, will aid materially in improving their quality, and the employment of more scientific methods, such as the processing of eggs and the marketing of drawn poultry, will do much to insure the goods being of better quality, and will materially benefit the whole industry.

By applying scientific care and management to the stocks intrusted to their keeping, warehousemen can also do much to insure the delivery of products that are in prime condition. By rendering as great a service as possible to the storer of these products they will be stabilizing their own industry and safeguarding its future.

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